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GLOSSARY

A	A letter for airplane maintenance interval
AD	Airworthiness Directive
ALPA	Airline Pilots Association
AOG	Airplane on Ground
ARAC	Aviation Rulemaking Advisory Committee
ASM	air separator module
ATA	Air Transport Association of America
ATB	air turn back
BITE	built-in test equipment
C	A letter for airplane maintenance interval
CBT	computer-based training
CWT	center wing tank
DDG	dispatch deviation guide
e.g.	for example
ER	extended range
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation; fuel/air ratio
GBI(S)	ground-based inerting (system)
HWG	Harmonization Working Group
JAA	Joint Aviation Authorities
LRU	line-replaceable unit
LS	lump sum
MEL	minimum equipment list
MMEL	master minimum equipment list
MO	modification order
MSG-3	Maintenance Steering Group—volume 3
MTBF	mean time between failure
MTBUR	mean time between unscheduled removal
NEA	nitrogen-enriched air
NIOSH	national institute for occupational safety and health
NTOF	National Traumatic Occupational Fatalities
O_2	oxygen
OBGI(S)	onboard ground inerting (system)
OBIGG(S)	onboard inert gas generating (system)
OEM	original equipment manufacturer
OSHA	Occupational Safety and Health Administration
PC, PCA	preconditioned air
PRV	pressure relief valve

PSA	pressure-swing adsorption
SB	service bulletin
TCAS	traffic collision avoidance system
U.S.	United States

1.0 INTRODUCTION

1.1 THE TASK

The Airplane Operations & Maintenance Task Team was assembled by the Working Group to support the Fuel Tank Inerting Study. The primary functions of this team were to.

- Review operational and maintenance data on existing fuel tank inerting systems.
- Evaluate the impact of the proposed inerting system design concepts on airplane operations, maintenance, and fleet planning.
- Evaluate the cost impact of the various proposed inerting system concepts on flight operations, ground operations, and maintenance
- Provide technical expertise in the area of airplane operations and maintenance to the other working group teams.
- Document the results of the Team's findings.

1.2 THE TEAM

The Team's membership was comprised of individuals with extensive experience in airplane flight operations, maintenance, ground operations, engineering, and aviation regulations.

To divide the workload and to address all impacts on operations and maintenance the Team splited up into four sub-teams. The sub-teams are:

- Modification/Retrofit,
- Scheduled Maintenance,
- Unscheduled Maintenance/Reliability, and
- Flight/Ground Operations.

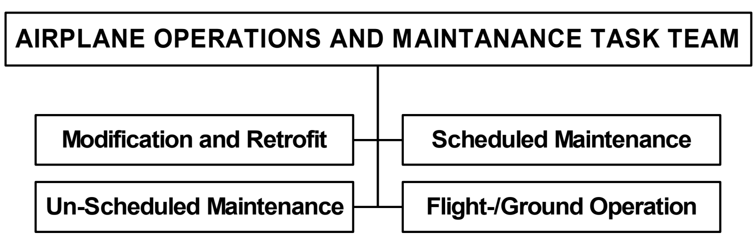

Figure 1-1. Team Structure

1.2.1 Modification/Retrofit Sub-team

This sub-team identified and quantified the costs and impact associated with modification of each of the existing airplane types to install the various inerting systems. The sub-team assumed that the modification would be done per an airplane manufacturer's service bulletin (SB) that provided modification data, and that the manufacturer would make available modification kits. The sub-team considered two different modification scenarios: First, the airplane is modified during a regularly scheduled heavy maintenance check. Second, the airplane is modified during a dedicated maintenance visit. The advantage of the first scenario is that access to most maintenance areas is already open for the regular maintenance check, which would reduce the total labor requirement, cost of modification, and airplane time out of service.

They developed data and estimations for each of the airplane/system combinations. These estimates were to include but not be limited to material/kit costs, modification labor-hours, engineering support requirements, technical publication revisions, airplane time out of revenue service, spares and training requirements, and any other issues related to the retrofit of inerting systems on existing airplane.

1.2.2 Scheduled Maintenance Sub-team

This sub-team identified and quantified the costs and impact associated with the routine maintenance of the inerting system as well as any effects the inerting systems might have on the maintenance requirements of other airplane systems or equipment.

The sub-team developed data for each of the airplane/system combinations. This data would include but would not be limited to airplane and component maintenance tasks, task intervals, task labor-hours, estimate of annual scheduled maintenance labor-hours, annual material costs, and the impact on check schedules, tooling requirements, and all other aspects of scheduled maintenance.

1.2.3 Unscheduled Maintenance Sub-team

This sub-team identified and quantified and quantifying the costs and impacts associated with the non-routine maintenance of the inerting system. They would also work with the Design, Rulemaking, and Safety Teams to define master minimum equipment list (MMEL) requirements and limitations.

They also developed data for the cost and impact of unscheduled maintenance on each of the airplane/system combinations, including but not limited to:

- Line maintenance tasks,
- Line maintenance labor-hours for troubleshooting/repair based on reliability data
- Delay and cancellation rates
- Airplane-on-ground (AOG) time
- Line maintenance training requirements and costs
- Component overhaul interval, labor, and material costs

And all other impacts related to unscheduled maintenance and system reliability as measured in mean time between failures (MTBF) or mean time between unscheduled removals (MTBUR).

1.2.4 Flight/Ground Operation Sub-team

This sub-team identified and quantified the operational issues, impact, and costs associated with flight operations and gate or ramp operations needed to support airplane equipped with inerting systems for each of the inerting systems concepts. They also analyzed and developed data relating to training requirements, airplane servicing, flight dispatch requirements and resources, cost-to-carry estimates, flight operating manual procedures, and manual revisions for each of the airplane/system combinations.

2.0 METHODOLOGY

2.1 DATA REVIEW

The Team's first task was to search for and review all available documentation relating to the operation, maintainability, and reliability of airplane fuel tank inerting systems. Searches of libraries and databases belonging to U.S. and European regulatory agencies, the Airplane Pilots Association (ALPA), the petroleum industry, airplane manufacturers, and U.S. military services were conducted as well as a search of the Internet.

For the most part, very little publicly available data on airplane fuel tank inerting systems exists. The Team did identify some reports, primarily FAA studies, including one on the modification of a DC-9 to incorporate a fuel tank inerting system 30 years ago. With the exception of the data produced as a result of the 1998 ARAC Fuel Tank Harmonization Working Group and a year 2000 FAA Technical Center report on ground-based inerting, none of these reports included any operational or maintenance data relevant to the current study.

Several military fuel tank inerting system applications similar to those being considered for this study were identified. However, the Team could obtain very little operational, maintenance, or reliability data on those systems because that data is classified.

2.2 INERTING SYSTEM CONCEPT REVIEW

As information became available from the Ground Based and On-Board inerting Design teams the Operations and Maintenance team began reviewing the systems to identify operational and maintainability considerations for each of the concepts. Each of the concepts was initially evaluated to identify how it might impact airplane flight operations, ground operations, dispatch reliability, maintainability, and training requirements. The potential impact to passengers, crews, and maintenance personnel safety was also considered.

After this initial evaluation, the Team split up into sub-teams to begin detailed analyses. The four sub-teams addressed Modification/Retrofit, Scheduled Maintenance, Unscheduled Maintenance/Reliability, and Airplane Flight/Ground Operations.

2.3 MODIFICATION

2.3.1 General

The inerting systems would be installed via modification or retrofit. The original equipment manufacturers (OEM) would retrofit airplanes in production. The OEMs would also need to provide modification to operators via a service bulletin. Operators, maintenance facilities, or OEMs will modify in-service airplanes.

An FAA approved OEM service bulletin for retrofit of an inerting system should be available before any final rule compliance date is set for retrofit of in-service airplanes. Failure to do this has caused problems for operators in the past. For example, in 1998 the FAA issued an Airworthiness Directive (AD) for 747-100/200/300/SP/SR series airplanes to change the wire separation requirements for Fuel Quantity Indicating System (FQIS) wiring. Although an approved retrofit solution was not available, a 3-year AD compliance time for airplane modification was set. The FAA expected the OEM to complete design changes, gain approval and make a service bulletin available within 1 year of the effective date of the AD. This would allow the operators two years to modify their affected fleet. However, FAA approved retrofit solutions did not become available until almost 24 months into the compliance period, thereby significantly impacting the operator’s ability to complete the modifications within the remaining compliance time. Because of the potential for delays in the design approval, it is critical that prior to the establishment of any compliance date requiring installation of an inerting system, an approved service bulletin must be available. This will insure that operators have sufficient time to complete the modifications within the compliance period of a rule.

Due to the scope of the modification, it must be accomplished during a heavy maintenance check or a special visit. Estimates have been developed for both scenarios.

The modification estimations are split into two major parts. The first is the non-recurring costs that comprise engineering time, technical publication changes, and material control. The labor-hour estimate for these nonrecurring costs is the same for all airplane categories. The nonrecurring estimates shown in attachment A-1 are per airplane type per operator. The second part of the modification estimate includes recurring costs and comprises actual airplane modification time. This portion of the estimate is per airplane.

The total modification costs and labor-hours estimation is shown in addendum F.A.1. A short description of each topic is presented below.

2.3.2 Engineering

Before a modification can be accomplished, the operators engineering department must review the OEM service bulletin to determine applicability and check for variations in airplane configurations. Then the modification order (MO) must be written, including creation of the necessary drawings and job cards, and coordinate with the maintenance and material planning organizations. After the MO has been completed and is ready for production, engineering has to create the necessary tracking numbers and maintain the records for all components and their trends. The maintenance program must be updated prior to release of the first modified airplanes. The engineer assigned to this modification becomes the project manager. In addition to the above-mentioned responsibilities, he/she will be assisting and monitoring the progress of this modification.

2.3.3 Technical Publications

The introduction of the inerting system affects the following technical publications:

- Airplane Maintenance Manual
- Illustrated Part Catalog
- Component Maintenance Manual
- Airplane Flight Manual
- Flight Operations Manual
- Structural Repair Manual
- Fuelling Manual
- Ramp Maintenance Manual
- General Maintenance Manual (including company procedures)
- Wiring Diagram Manual
- Weight and Balance Manual

In the modification estimation analyses, the Team assumes that the normal revision procedures of the airplane manufacturer are used. The estimated time is the time that is required to revise the manuals.

2.3.4 Material Control and Kits

The inerting system introduces new serialized parts and consumable parts. Those new parts have to be added to the company's databases. Due to the lack of data on the inerting system, the material cost of consumables is not taken into account.

Prior to the establishment of any compliance date requiring installation of an inerting system, modification kits must be available and the airframe manufacture should coordinate the flow of kits to the operators. In this way, large operators will not adversely affect the availability of kits for smaller operators

Kit costs—the price of the kit, storage costs, and the labor-hours needed to check it—are not taken into account because of the large variation between airplanes, which prevents the use of detailed generic data and pricing.

2.3.5 Project Estimation
For the modification estimation, the following airplane types were used as examples of each of the six category airplanes:

- Large airplane type category—Boeing 747 series.
- Medium airplane type category—Boeing 767 and MD11.
- Small airplane type category—Boeing 737.
- Regional fan airplane type category—Fokker 28 and 70.
- Regional prop airplane type category—No airplane[1].
- Business jet airplane type category- Gulfstream IV.

Addendum F.A.2 shows the task with the labor-hours to do the project. For this estimation, it is assumed that the airplane has integrated tanks. Rubber cells are used by the Fokker 28/70/100 series airplanes and as auxiliary tanks on some other transport airplanes. Introduction of the inerting system requires modification or redesign of the rubber cells. For the regional turbofan airplane category, estimates for airplanes with bag-tank (rubber cells) are made as well. Neither is the time that is required for moving or replacing existing installations to accommodate the piping of the inerting system.

The engineering support requirements (e.g., engineering, technical publications, material management) for retrofit of an operator fleet are based on a nominal fleet size.

2.3.6 Airplane Out of Service Time Estimate
To estimate the downtime for the airplane, the following assumptions are made:

- Modification is accomplished on a five-day workweek.
- There are three shifts each with 10 people (5 mechanics, 3 avionics, and 2 sheet metal workers).

2.3.7 Maintenance Training
The basic training requirement for this fuel tank inerting modification consists of classroom lectures, use of the jet airplane maintenance fundamentals, computer-based training (CBT) courseware, basic training workshops, and practical training on in-service airplane at a maintenance organization. A substantial amount of time is needed to educate and train the professional maintenance technicians who will be responsible for safely handling and maintaining airplanes that are equipped with inerting systems.

Operator maintenance and ground training departments, and vendor and manufacturer training departments, will need a substantial amount of time to create and present all necessary training materials for the different kinds of inerting systems. The diversity of airplane fleets and available inerting systems will compound this challenge.

Existing training manuals will need to be revised to reflect airplane modifications and operational requirements posed by fuel tank inerting.

There are significant differences in training regulations between the various countries An accurate estimation would require knowing the exact number of licensed mechanics and the average number of

[1]For the regional prop airplane types no estimation is made, this because the Team could not find a company that does the maintenance for propeller airplanes with a center wing tank. Fokker Services, who did the estimation for the regional turbofan airplanes, indicated that the Fokker 27, 50 and 60 airplanes, which are turboprop airplanes, do not have a center wing tank.

licensed mechanics per airplane per operator. An additional factor is the fact that some operators contract with training centers to educated their maintenance personnel. Due to these and other factors the Team was not able to make a labor-hours estimate for training costs. However the Team described the impact on maintenance training due to the introduction of inerting systems.

2.4 MEL RELIEF

The Federal Aviation Regulations (FAR) require that all equipment installed on an airplane be in compliance with the airworthiness standards and operating rules must be operative. However, the FARs also permits the publication of a minimum equipment list (MEL) where compliance with certain equipment requirements is not necessary in the interests of safety under all operating conditions. Experience has shown that with the various levels of redundancy designed into an airplane, operation of every system or installed component may not be necessary when the remaining operative equipment can provide an acceptable level of safety. Under the MEL, dispatch relief is granted for listed components and systems for specific periods of time before the system or component must be repaired or made operational. If repair is not made before the specified time period expires, the airplane may not be flown again until the repairs are made. The FAA uses several standard “repair intervals” that range from one flight to 120 days.

2.4.1 Primary Assumptions

As defined in the Tasking Statement, “Evaluations of all systems should include consideration of methods to minimize the cost of the system. For example, reliable designs with little or no redundancy should be considered, together with recommendations for dispatch relief authorization using the master minimum equipment list (MMEL) in the event of a system failure or malfunction that prevents inerting one or more affected fuel tanks. The Working Group in general and the Airplane Operations and Maintenance Task Team specifically felt that these instructions were contradictory to the normal application of the MMEL.

These assumptions vastly affect the maintenance and operational costs for an airplane equipped with a fuel tank inerting system. Requiring system redundancy would greatly increase the cost and complexity of the inerting system. System redundancy would also greatly increase maintenance and operating costs.

Likewise, if dispatch relief were not available on a system without redundancy, the maintenance requirements would be greatly increased. In addition, the rate of flight delays and cancellations would increase significantly because the system would have to be repaired before flight.

After lengthy discussions at the Team and Working Group levels it was decided to proceed with the evaluation using the guidelines in the tasking statements. However, it must be understood that airplane operations and maintenance costs would significantly increase with a change to either of these assumptions. Because all of the working group’s analysis is based on these two assumptions, changing them would invalidate most of the results.

For purposes of the study, the Airplane Operations and Maintenance Task Team made an attempt to evaluate the impact of a Category B or three-day repair interval and a Category C or 10-day repair interval. The impact was evaluated based on the reliability of the system, the typical amount of ground time between flights, and the typical maintenance capture rate or the frequency that an airplane overnights at a maintenance base. An effort was also made to predict the impact of having no dispatch relief, which essentially meant that one or more flights would be cancelled while repairs were being accomplished. While these estimates are not comprehensive, they suggest the potential impact of the various options.

2.4.2 Frequency of Dispatch on MEL

To determine how frequently an airplane might be dispatched with the inerting system inoperative, the average annual flight hours for the specific airplane type was divided by the inerting system reliability factor of mean time between unscheduled removals (MTBUR) to determine the typical frequency of inerting system failures. Available time to troubleshoot and repair the system between flights is typically very short. Therefore, the assumption was made that, given the availability of dispatch relief per the MEL, maintenance would probably place the system on MEL and dispatch the airplane with the system inoperative rather than creating a lengthy flight delay.

2.4.3 Flight Delays

To dispatch an airplane with a system or component on MEL, some minimal amount of troubleshooting by a mechanic is required to identify the problem and verify that the system is safe for continued flight in its existing condition. The mechanic must also check the MEL to determine if there are maintenance procedures to deactivate or reconfigure the system prior to dispatch. The mechanic must then fill out the proper paperwork to place the system on MEL and release the airplane. The shorter the turn time, the more likely a significant flight delay would occur. The availability of maintenance is also a factor because the number of available mechanics is very limited at many airports. Typical flight delays can range from a few minutes to several hours depending on the maintenance workload at the time, weather conditions, and so on. To reflect the potential impact on flight schedules for each dispatch on MEL, the following flight delay times (Figure 2-1) were assumed based on the typical turn time for that category airplane.

Airplane Category	Flight Delay per MEL Dispatch
Large Transport	30 Minutes
Medium Transport	45 Minutes
Small Transport	60 Minutes
Regional Turbofan	60 Minutes
Regional Turboprop	60 Minutes
Business jet	60 Minutes

Figure 2-1. Flight Delay Assumptions

The annual number of delays and delay time is then a function of the number of times the system fails and must be put on MEL times the estimated delay time per MEL dispatch.

2.5 SCHEDULED MAINTENANCE

The Scheduled Maintenance sub-team was tasked with identifying and quantifying the costs and impact associated with the routine maintenance of an inerting system. Each of the proposed inerting systems was to be addressed for each of the six airplane types. (Airplanes had been grouped according to standard seating configuration and the airplane models were then placed into the six categories under consideration.) However, due to the size and complexity of the On-board Inerting concepts, analysis was not completed for Turbofan, Turboprop, and business jet category airplanes.

Scheduled maintenance requirements should be minimal based on the following assumptions:

- Most components will be maintained on condition.
- The design of the system will be such that the risk of an undetected accumulation of nitrogen in spaces occupied by people or animals in flight or on the ground will be minimized.
- Failure of the inerting system will not provide any immediate risk to the airplane or its occupants.

A Boeing 757 (small airplane category) was chosen to establish a baseline of maintenance tasks and intervals. From there, it was believed that maintenance intervals and data could be established for other airplane categories by scaling the B757 data as applicable.

In order to facilitate the calculation of scheduled maintenance labor-hours for each of the selected inerting systems, average utilization rates (Figure 2-2) and maintenance intervals were obtained from Boeing and Airbus for all their jetliner models. From this information, the average maintenance intervals were calculated and are presented in Figure 2-3. This information was used to determine the frequency, or portion, of each maintenance check per year. From that, the average additional labor-hours per year required for scheduled maintenance of an inerting system could be established.

Airplane Category	Daily flight hours (hrs.)	Annual flight hours (hrs.)	Flights per day (avg. no.)	Min. Turn time (min.)
Large Transport	11.18	4081	2	60
Medium Transport	7.65	2792	3.5	45
Small Transport	7.86	2869	7	20
Regional Turbofan	5.8	2117	7.1	15
Regional Turboprop	8.1	2957	6.8	15
Business jet	1.37	500	1.5	60

Figure 2-2. Airplane Average Utilization by Category

Airplane Category	Check Intervals (hours)		
	A	C	Heavy
Large Transport	650	5,000*	4C
Medium Transport	500	4,350**	4C
Small Transport	500	6,000**	4C
Regional Turbofan	400	4,000	4C
Regional Turboprop	500	3,200	9,600
Business jet	400	4,000	16,000

* = or 24 months ** = or 18 months

Figure 2-3. Average Fleetwide Maintenance Intervals

2.5.1 Maintenance Labor-Hours

Maintenance labor-hours were estimated for the model B757 airplane. These labor-hours were to be scaled to determine the additional scheduled maintenance labor-hours for other airplane categories, but no significant differences between categories were discovered. From the information available, components between airplane categories do not vary significantly. Although the size of components may differ, the scheduled maintenance labor-hours needed to inspect and/or remove and replace these components does not. When compared with a small airplane type, medium and large airplane types will require additional labor-hours during a heavy check to inspect the wiring and ducting because of the additional wiring and tubing.

Scheduled maintenance tasks and inspection intervals for components within each concept were obtained using tasks and intervals for similar components on existing airplanes, or components performing similar functions on the V-22 Osprey. It is important to note that the V-22 Osprey currently operates with Fuel Tank Nitrogen Inerting System.

To obtain the estimated labor-hours for each maintenance task for similar components (e.g., components in ATA[2] 21, 28, and 36) used in-service airplane models were identified, and maintenance personnel were then queried as to whether the labor-hours per task were reasonable. The reason that this estimate was based partly on the expertise of the maintenance personnel is that the actual locations of components would not be known until an inerting system is actually designed.

2.5.2 Cycles vs. Operating Time

It is important to note that the Ground Based Inerting System (GBIS) and the On Board Ground Inerting System (OBGIS) maintenance intervals are based on cycles and an average system operating time per

[2]Airplane manuals are divided in chapters according the ATA standards. Each chapter described a specific airplane system. The ATA chapters referred here are respective “Air-conditioning” (ATA 21), “Fuel System” (ATA 28), and “Pneumatic System” (ATA 36).

cycle. On Board Inerting Gas Generator System (OBIGGS) maintenance intervals are based on flight hours plus ground operating time.

Scheduled maintenance for the Ground Based Inerting system was excluded at the heavy check for small, medium, and large airplanes. Due to the limited amount of equipment internal to the airplane or the fuel tanks, it was assumed that C-check inspections would suffice.

The team excluded scheduled maintenance for the GBIS at the heavy check for small, medium, and large airplanes. Because the amount of equipment internal to the airplane or the fuel tanks is limited, we assumed that C-check inspections would suffice.

Scheduled maintenance for the Ground Based Inerting System on business jets would be required on an annual basis.

2.5.3 Additional Maintenance Tasks

There are numerous maintenance checks that will be required but cannot be evaluated until final designs are determined. These would include, but are not necessarily limited to, pre-departure checks (BITE checks, fault checks, extended range checks, and so on) as well as pre-tank entry checks (which will be dependent upon the actual operator and/or equivalent of OSHA). In addition, unusual scheduled tasks based on the system chosen (e.g., daily warm-up period for membrane OBIGGS) are not included here.

There are other scheduled maintenance items that cannot be included because of the peculiarities of each system, because they will not be known until the system has been designed. Without knowing the design life of many of the components to be used in the proposed inerting systems, the labor-hours required for scheduled removals could not be estimated. These include specific consumables, other than filters, that are only required by the design itself (e.g., liquid nitrogen for the cryogenic inerting system).

It was recognized that a true picture of the maintenance program could only be achieved by performing an MSG-3[3] analysis. However, lack of design data prevented that from being accomplished for this report.

2.6 UNSCHEDULED MAINTENANCE

2.6.1 Component Reliability

As mentioned earlier in this report, there is little or no existing documentation relating to the operation, maintainability, and reliability of airplane fuel tank inerting systems. The challenge for the Team has been to develop a reasonably accurate method to estimate the reliability of the fuel tank inerting system design concepts.

After a review of each of the design concepts, the similarity between the proposed inerting systems and other existing airplane systems became evident. For many of the components, there are even strong similarities with fuel, pneumatic, and air conditioning system components currently used on commercial airplanes. In fact, there is a possibility that some existing valves, sensors, or fans currently used in other systems could be used in an inerting system. Therefore, for each inerting system component, as many similar airplane components were identified as possible. The information on similar components and available reliability data for those components were gathered and averaged. For components that are unique to the inerting systems, such as air separation modules, the manufacturers' estimates of the components' reliability were used.

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[3]MSG-3 (Maintenance Steering Group – Version 3) is a document produced by the Air Transport Association of America that outlines a decision and selection process for determining the scheduled maintenance requirements initially projected for an airplane system or power plant

2.6.2 MTBF vs. MTBUR

It was determined that the mean time between unscheduled removals (MTBUR) rather than the system mean time between failures (MTBF) would be a better indicator of the impact on the airplane maintenance requirements and operational performance. MTBUR factors in some of the typical maintenance inefficiencies in system troubleshooting and repair and, therefore more accurately reflects the real-world problems encountered in airplane maintenance.

2.6.3 Airplane Utilization Rate

To assure uniform and consistent analyses methods when evaluating the impact to maintenance and operations, airplane utilization rates were determined for each of the study category airplanes based on industry data (Figure 2-4). These utilization rates included daily and annual airplane flight hours as well as the number of daily operations per airplane. Industry data was also used to determine minimum turn times with input from airplane representatives on the Working Group (Figure 2-4).

Airplane Category	Daily flight hours (hrs.)	Annual flight hours (hrs.)	Flights per day (avg. no.)	Min. Turn time (min.)
Large Transport	11.18	4081	2	60
Medium Transport	7.65	2792	3.5	45
Small Transport	7.86	2869	7	20
Regional Turbofan	5.8	2117	7.1	15
Regional Turboprop	8.1	2957	6.8	15
Business jet	1.37	500	1.5	60

Figure 2-4. Airplane Average Utilization by Category

2.6.4 System Reliability

The system reliability was then simply calculated as an inverse sum of the MTBUR inverses. The same method was used to determine the system reliability for each of the inerting system concepts.

2.6.5 System Annual Utilization Rates

Because of differences in the operating requirements and characteristics of each inerting system design concept, the amount a specific system operates varies. System operating time is important because it directly affects system reliability and therefore operating costs. To account for these differences, the system annual utilization rates were developed based on the operating requirements for each inerting system concept and each category of airplane.

2.6.6 System Annual Failure Rate

The inerting system failure rate was determined by multiplying the system MTBUR by the system annual utilization rate for the category airplane. This rate was then used as an estimate of the frequency that the airplane would be dispatched with the system inoperative (MEL). Along with the MEL repair interval requirements, it was used to estimate the percentage of time the system would be operational.

2.6.7 System Maintenance Workload

To determine the amount of additional workload an inerting system would add to an airplane's maintenance requirements, some assumptions about the location of the inerting system components had to be made. Working with the design teams, the likely locations of components were identified. Identifying potential locations on some airplane types was relatively easy. On the 747, for example, an area beneath the center wing tank adjacent to the air-conditioning packs was determined to be large enough for an on-board system and it met most of the design and safety requirements. This location would also provide good maintenance accessibility. On other airplanes, space was found to be very limited. Many of these spaces were inside the fuselage pressure vessel, raising safety concerns, and they tended to have poor accessibility for maintenance. On some airplanes, space inside wheel wells and wing-to-body fairings was determined to be available. In many others, the only potential locations tended to be in the aft fuselage area just forward or behind the aft pressure bulkhead. The Team also considered differences in access time due to the time necessary to purge the fuel tanks because of the differences in fuel tank volumes.

Based on this survey of potential locations, estimates were developed for troubleshooting, removal, and installation of each component. From this estimate and the components' predicted failure rate, a maintenance labor estimate was developed for the system aboard each airplane type.

2.7 FLIGHT OPERATIONS

In order for Team to evaluate this process and come to the conclusions and recommendations stated further in this document, several implications and assumptions needed to be applied uniformly. First and foremost was the assumption that in the event that the inerting system was inoperative or that ground inerting equipment was not available, a means to dispatch the airplane without the fuel tanks inerted must be defined. Much discussion went into this decision, ranging from requiring inerting on every flight regardless of circumstances to treating the system as supplementary only. In the event MEL or dispatch relief was not available, operators would incur major limitations. The scope of such limitations could be so great as to cause changes to entire route structures. Airports without the capability to provide nitrogen or maintenance procedures would not be available as alternates, refueling stops, or for diversions as their use would have the potential to ground airplanes and passengers short of their destinations. If the inerting systems were required for safety of flight additional air turn-backs, flight cancellations and delays would also have to be considered. This and the guidelines set forth in the Tasking Statement led the Team to a final premise. Consequently, the Team's evaluation and methodology regarded the system as being a safety enhancement system similar to the present TCAS systems required on airplanes today.

The cost-to-carry estimates are a function of the weight of the system and the cost of the fuel to carry the additional load. The loss of revenue due to the decrease in useful load on flights routinely operating at maximum gross weight is also considered. Because determination of the cost associated with the production of power and resultant drag incurred by on board system designs requires detailed design data, these costs have not been quantified.

Flight crew procedures and associated training expenses were derived from past typical training events similar to the requirements of the proposed system. It was also assumed that the FAA as a training aid from a high-level or general standpoint would publish an Advisory Circular.

2.8 GROUND OPERATIONS

The effect an inerting system has on ground operations depends on the system concept being considered. Training, ground handling and line maintenance requirements were considered along with the associated costs. To accomplish this, a conceptual model of operations with ground based & on-board inerting systems were developed based on the inerting system concepts and airplane operational experience.

The Team also assumes that the FAA will provide guidelines in Advisory Circular material addressing training specifically for Operators and Technicians. Recent modifications to Boeing 737 center fuel tanks, along with the installation of the Smoke Detection and Fire Suppression system in class "D" cargo compartments, allowed the Team to draw some interesting parallels in the processes under review. Based on the modification and training requirements involving the aforementioned systems, a generic description of the model is as follows:

> Training programs for line maintenance technicians should cover system operation, MMEL processes and special procedures, including troubleshooting procedures. While Operator training requirements, internal policies and procedures vary widely, task specific training for technicians accomplishing the initial airplane modification should be implemented. A separate or additional program dealing with nitrogen safety and usage

should be developed for those individuals working around the airplane during the inerting process. This team estimates that eight hours (8) of initial, and four hours (4) of annual recurrent training would be required for each technician.

3.0 MAINTENANCE IMPACTS

3.1 INTRODUCTION

The retrofit and operation of any of the proposed inerting systems will significantly effect airplane maintenance programs & schedules, dispatch reliability, the maintenance work load in the line environment, and the safety of the maintenance personnel.

3.2 MODIFICATION AND RETROFIT

It is the conclusion of this Team that due to the scope of the modifications, most operators would not be able to schedule the modifications to incorporate the inerting system during an airplane's regular heavy maintenance visit (see addendum F.A.1). The large number of additional labor-hours would extend the scheduled maintenance visit so much that it would interfere with the airline's maintenance schedules. Operators must complete the maintenance requirements on schedule or risk grounding airplanes. Therefore, most operators would likely start-up dedicated modification lines or contract the modifications out to other maintenance facilities. The disadvantage of this approach is that the existing access that is available during heavy maintenance visits is lost. This increases the total labor-hours required for the modification slightly. Another disadvantage of this approach is it may cause a worldwide problem with the hangar availability. The Team estimated that approximately 100 dedicated hangars would be necessary for modification of the existing fleet during the proposed compliance period. When the operators need to do the modification in a special modification line extra slots are necessary, this may result in insufficient hangar space.

Because of the number of airplanes effected, the Airplane Operations & Maintenance team has serious concerns about the availability of enough trained Airplane Maintenance Technicians that would be required to modify the airplanes in the proposed compliance period. Completing the modification of all the effected airplane in a seven-year period would require 3000 - 4000 trained Maintenance Technicians working full time.

3.3 MEL RELIEF

As discussed earlier, the assumption of dispatch relief for the fuel tank inerting system is fundamental to estimating its potential impact on airplane operations and maintenance. If the assumption changes, the approach taken to evaluate the scheduled maintenance requirements would also need to change, resulting in a significant increase in estimated time and costs.

If a typical airplane could not dispatch an airplane with its inerting system inoperative, the airplane might have to be taken out of service to repair failed inerting systems. The result would be a heightened burden on the airplane's line maintenance functions to get the airplane back into service. Therefore, airplanes would most likely focus on the inerting system's scheduled maintenance program, driving many components off the airplane for overhaul earlier in an attempt to reduce system failures in service. This would significantly increase the scheduled-maintenance, overhaul, and operating costs for the inerting system.

3.4 SCHEDULED MAINTENANCE

Scheduled maintenance impact, as shown in the specific inerting design concept sections, reflects access, inspection of component, and closure but does not reflect any non-routine correction of discrepancies. Nor does it include the cost of any special equipment or tooling that may be required to accomplish the inspections.

Scheduled maintenance impact, as shown in each specific inerting design concept sections, does not reflect any of the costs related to the airplane's modification. Instead, it begins after the inerting system has been incorporated.

The heavy check inspections shown for the different inerting design concepts do not reflect any additional manpower that might be required to comply with safety requirements on fuel tank entry into confined spaces with NEA present.

Airplane fuselage seal deterioration occurs because of increasing airplane age, and pressure decay checks allow discovery of seals, which require replacement or rework. The use of cabin air as a supply for the inerting system increases the demand on the airplane air-conditioning packs. Consequently, the maximum allowable cabin leakage rate will have to be maintained at a lower level to ensure that the airplane air-conditioning packs will be able to continue to maintain the required cabin pressurization.

For the On-Board Inerting Gas Generator system, extra labor-hours have been added to the C-check and heavy check to perform a fuselage pressure decay check and rectification because of the use of cabin air as supply for the inerting system. Operator experience has shown that airplanes that are currently in service periodically require this pressure decay check in order to maintain limits prescribed in airplane maintenance manuals.

The extra labor-hours are averages obtained from those operators whose maintenance program currently require fuselage pressure decay checks.

3.5 UNSCHEDULED MAINTENANCE

Each of the design concepts that were included in this study, from the least complex (ground-based inerting) to the more complex (onboard inerting gas generating system), will impact line maintenance, as would the introduction of any new system onto an airplane. From a general perspective, the introduction of a new system—and hence the introduction of new components or line replaceable units (LRU)—will impact line maintenance by affecting airplane dispatch reliability.

In simple terms, the more components there are, the less reliable the system, which results in a lower overall airplane dispatch reliability rate. The reliability of each component or LRU, and specifically its MTBUR, directly relates to an unscheduled line maintenance activity. This, in turn, means an increase in labor-hours (troubleshooting, component access, and component removal and replacement times), material and labor costs, and most likely an increase in airplane delays and cancellations. Additionally, the introduction of a new system and its components can impact other systems by affecting access to their components, thus affecting unrelated component replacement times.

As discussed previously, the specific impact on line maintenance due to the introduction of inerting is best evaluated by looking at component MTBUR data for similar or related systems. Additionally, the impact on other systems due to operation of the various inerting systems must be considered. For example, the proposed OBIGGS design concept extracts cabin air as an air source during certain flight phases. Although a scheduled maintenance task to accomplish a periodic fuselage pressure decay check will need to be implemented as indicated earlier, cabin air extraction will undoubtedly affect airplane pressurization, especially on older airplanes, leading to unscheduled maintenance activities and associated costs to isolate and rectify air losses. The impact to line/unscheduled maintenance varies depending on the inerting system utilized. These differences are discussed in more detail in each of the system design concepts sections. Unscheduled maintenance costs associated with component overhaul (including labor and material costs) and costs associated with special equipment and tooling were not included in the analysis due to insufficient data.

Finally, special precautions must be enforced when performing line maintenance on some inerting system components (depending on their location), such as confined space entry procedures. Additional hazards associated with gaseous or liquid nitrogen must also be considered. These special precautions and additional hazards result in increased line maintenance costs through increased training (both initial and recurring), equipment, and procedural/policy implementation costs. The specific issue related to maintenance personnel safety associated with nitrogen inerting systems is discussed in more detail in section 3.5 below. Also, because of the unique safety precautions associated with performing line maintenance tasks on inerting system components, specially trained line maintenance personnel (similar to wet cell entry-skilled personnel) may be required. Some airplane operations may opt to utilize contracted personnel to perform such tasks.

3.6 MAINTENANCE SAFETY

3.6.1 General

Nitrogen and other inert gases are not normally dangerous, but when used in confined spaces they can create oxygen-deficient atmospheres that can be deadly. Nitrogen is especially hazardous, because it cannot be detected by human senses and can cause injury or death within minutes. In the United States, at least 21 people have died in 18 separate incidents between 1990—when more stringent requirements were adopted—and 1996, involving the use of nitrogen in confined spaces. Every year in the United Kingdom, work in confined spaces kills an average of 15 people across a wide range of industries, from those involving complex plants to those using simple storage vessels. Fatalities include not only people working in confined spaces, but also those who try to rescue them without proper training or equipment. Still more people are seriously injured.

The health risk to ground and maintenance personnel servicing airplanes that use nitrogen inerting technology is present not only in the fuel tanks themselves, but also in the location of the nitrogen-generating equipment. Wherever possible, such equipment should be located outside the airplane pressure hull. However, this is not possible on all airplanes. Therefore, it will be necessary to ensure that safety systems and procedures are in place to protect the airplanes and personnel working in and around them.

The following sections highlight some of the hazards associated with operating fuel tank inerting systems on commercial transports and the risks they pose to the airplane, its occupants, and maintenance personnel.

3.6.2 Confined Spaces

The Occupational Safety and Health Administration (OSHA) defines a confined space as a space that by design

- Has limited openings for entry and exit.
- Has unfavorable natural ventilation.
- Is not intended for continuous employee occupancy.

OSHA further defines a "permit-required confined space" as a confined space with

- Hazardous atmosphere potential.
- Potential for engulfment.
- Inwardly converging walls.
- Any other recognized safety hazard.

By this definition, all airplane fuel tanks meet the OSHA definition of a permit-required confined space. If the tanks were to be inerted, the current requirement to ventilate fuel tanks before entering will be critical. In addition, other locations under consideration for housing nitrogen-generating equipment, such as cargo holds, wheel wells, wing-to-body fairings, and APU bays, may also be considered confined spaces. As such, appropriate entry procedures must be in place to minimize the risk to workers entering these spaces. These areas should be clearly marked and workers thoroughly educated regarding both the hazards of confined space entry and the insidious nature of nitrogen asphyxiation and death.

The costs associated with implementing these additional confined-space entry procedures worldwide are estimated at $39.8 million for safety equipment and an additional $28.3 million per year in labor (see addendum F.D.1 in appendix F). Even with these procedures in place, accidents will continue to happen as a result of people bypassing or simply ignoring the procedures, as is proven annually by the current record of injuries and fatalities.

3.6.3 Gaseous Nitrogen

The most significant hazard associated with exposure to nitrogen is breathing the resulting oxygen-deficient atmosphere. Normal atmosphere is made up of approximately 21% oxygen, 78% nitrogen, and 1% argon, with smaller amounts of other gases. Nitrogen, which is colorless, odorless, and generally imperceptible to normal human senses, requires the use of oxygen-monitoring equipment to detect oxygen-deficient atmospheres. Despite its nontoxic profile, nitrogen can be quite deadly if not properly handled.

It is not necessary for nitrogen to displace all the 21% of oxygen normally found in air to become harmful to people. OSHA requires that oxygen levels be maintained at or above 19.5% to prevent injury to workers. Figure 3-1 summarizes the expected symptoms at various oxygen concentrations for people who are in good health.

Oxygen Concentration (% vol.)	Symptoms	Maximum Exposure
19.5%	None	N/A
14 – 19.5%	Labored breathing, particularly at higher workloads	N/A
12 – 14%	Physical and intellectual performance impaired, Increased heart rate	N/A
10 – 12%	Rapid breathing, dizziness, disorientation, nausea, blue lips	10 Minutes
8 – 10%	Loss of control, gasping, white face, vomiting, collapse	50% of people will not survive 6 Minutes 100% of people will not survive 8 Minutes
4 – 8%	Coma, Death	40 seconds 2 Minutes
< 4%	Death	Seconds

Figure 3-1. Personnel Hazards

The very nature of oxygen deficiency is that the victim becomes the poorest judge of when he or she is suffering from its insidious effects. Victims may well not be aware of their condition and could fall unconscious without ever being aware of the danger.

3.6.4 Liquid Nitrogen

For OBIGGS, which uses cryogenic methods, liquid nitrogen presents its own specific hazards. Although relatively safe from the point of view of toxicity, liquid nitrogen—in common with all cryogens—presents the following hazards:

- Cold burns, frostbite, and hypothermia from the intense cold.
- Over-pressurization from the large volume expansion.
- Fire from condensation of oxygen.
- Asphyxiation in oxygen-deficient atmospheres.

Skin contact with liquid nitrogen can cause tissue to freeze, resulting in severe burns. The extremely low temperature of the cryogenic liquid causes these burns, not by a chemical action. Liquid nitrogen contacting the aircraft structure may cause degradation of materials—especially deterioration of composites and stress cracks in aluminum—resulting in possible structural failure.

The risk of oxygen-deficient atmospheres when using liquid nitrogen arises from the vast expansion of the substance as it boils or vaporizes. Just one liter of liquid may produce around 700 liters of gas at atmospheric pressure, displacing significant quantities of breathable air if the gas is released in a confined space, such as an aircraft fuel tank or pressure hull. The problem is compounded by nitrogen's tendency to accumulate at low levels where it is less easily dispersed than the ambient atmosphere. Even an apparently small spillage could lead to dangerously low oxygen levels, presenting a serious hazard to personnel and other occupants in the area.

Another potential hazard when using cryogens is the risk of oxygen condensation from the atmosphere due to the extreme cold. Liquid oxygen is highly flammable, and may also create locally oxygen-enriched atmospheres carrying a greatly increased risk of fire or explosion, should an ignition source be present.

3.6.5 Gaseous Oxygen

Produced as a byproduct of the nitrogen generation process, gaseous oxygen presents its own potential hazards. The OBIGGS concepts are designed to vent oxygen overboard. However, some form of leak detection would need to be in place. Failure to do so may result in an oxygen-rich atmosphere with associated risk of fire and explosions. Many materials, such as clothing, that would normally only smolder in air will burn vigorously in an oxygen-enriched atmosphere, making it essential that staff members are alerted to high oxygen concentrations so that the risk of fire can be minimized.

3.7 MAINTENANCE TRAINING

To provide a safe working environment, operators are required to provide maintenance training prior to introduction of an inerting system. Training instructors have to modify their schedules, additional instructors may need to be hired, and training personnel will have to attend the vendors' and manufactures' classes. Afterward, these instructors have to spend time adapting vendors' training materials to their operator's standard. Only after the new training materials are finished and approved by the local regulatory authorities can regularly scheduled classes begin for maintenance and ground support personnel. The variety of airplane fleets and available inerting systems will require the mechanics and ground support personnel to be trained for all systems applicable to all airplane types in the operator's fleet. This fuel tank inerting training requirement will consist of classroom lectures; use of the jet airplane maintenance fundamentals, CBT courseware, and basic training workshops, as well as practical training on in-service airplane after the new systems is introduced.

4.0 OPERATIONAL IMPACTS

4.1 INTRODUCTION

The installation and operation of a fuel tank inerting system onboard an airplane significantly effects the daily operations of that airplane, the flight crew and ground support personnel. The system reliability will have an effect on flight schedules and airplane dispatchability. Flight crews will have to monitor the system to maintain operational safety. Ground support personnel will have to service ground based systems and everyone working on or around the airplane will have to maintain awareness of the potential hazards associated working around large quantities of nitrogen.

4.2 FLIGHT OPERATIONS

Potential impacts having the greatest effect on flight operations consist primarily of schedule effects, MEL and dispatch relief, lost revenue, operational safety, and training. The follow is a briefly discussion of the severity of the impact in relation to the degree of restriction chosen in a final rule. The impact spectrum ranges from inerting having a relatively minor affect on flight operations to it being impractical in service.

4.2.1 Schedule Impact

Potential impacts to flight schedules will vary greatly depending on the type of inerting system used, the type of operation and the availability of MEL/dispatch relief. Schedule delays due to inadequate turn times are likely to become significant in those operations that today routinely turn their airplanes around in less time than the systems were designed to accommodate. These types of delays are most likely to occur while using the ground based inerting design. To minimize the potential impact on flight operations, average minimum turn time data was collected from operators to determine the design goals for the inerting system concepts. Refer to Figure 4-1 below. The Ground Based Inerting and On-board design teams with the goal of minimizing the impact of inerting time on airplane turn times used this data. Under normal situations, the concept design goals should preclude the requirement for extended gate time. However, some operators with very quick airplane turns could still be affected.

Aircraft Catagory	Average Minimum Turn Time (Minutes)	Average Aircraft Cycles Per Day	Airplane Annual Utilization Rate
Small Transport	20	7	2869
Medium Transport	45	3.5	2792
Large Transport	60	2	4081
Business Jet	60	1	500
Regional Turboprop	15	6.8	2117
Regional Turbofan	15	7.1	2957

Figure 4-1. Average Minimum Turn Times

The costs associated with such delays may be quantified by taking the percentage of flights that normally operate below the minimum scheduled allotment and multiplying it by the industry-standard delay costs for each minute incurred.

MEL/dispatch relief or lack thereof, has the greatest potential to escalate costs exponentially. For this reason, the following section more fully addresses this issue. The installation implementation time for this proposal may also have a great effect if the modification cannot be accomplished during normally scheduled maintenance visits. If this proves to be the case, airplane out-of-service costs and drastically increased maintenance and hangar requirements will further escalate costs greatly as shown in addendum F.A.1.

4.2.2 Airplane Out-of-Service Time

For most operators, it would not be possible to schedule the inerting modification project during a regular heavy maintenance visit. The reason is the scope of the project (see appendix F, addendum F.A.1). The large number of required labor-hours would significantly extend the maintenance visit, which in turn would disturb the airplane's operational schedule.

4.2.3 MEL Relief

As discussed earlier the potential impact of MEL/dispatch relief or the lack thereof can not be emphasized enough, especially for on-board inerting systems. Without dispatch relief, every system malfunction would likely result in one or more flight cancellations. With estimated system failure rates ranging from 2-6 per year for each airplane the average operator could experience 1000-2000 additional flight delays and cancellations per year.

4.2.4 Lost Revenue

The factor associated with lost revenue is only an issue on the percentage of flights operating at or near maximum take-off weight for the specific flight. All other flights are not taken into consideration simply because the additional weight of the inerting system would not be expected to effect the planned revenue load, see the different design sections in this report[4] for costs associated with this function. Cost to carry, however, must be applied to all systems on every flight. This is a function of the inerting system design weight multiplied by the average industry cost per pound to demonstrate the increased fuel burn required supporting the system, see the different design sections in the report[4] for industry average costs to carry specified weights. Please note that these costs will vary greatly according to fluctuations in fuel prices. The costs associated with producing the power to run the systems such as electrical load, bleed load, or drag, will also need to be considered.

4.2.5 Flight Operations Safety

The major safety issues relating to flight operations are in regard to NEA leaking into the cockpit or passenger cabin, or the accumulation of highly concentrated O_2 at or near a fuel source. Due to these concerns, it is recommended that nitrogen/oxygen level sensors be installed to provide a warning case of a leak in critical areas. Flight crews and cabin crews will also need to be trained on how to react in the event of such an alarm. Under normal conditions in-flight, the air-conditioning system onboard the airplane will supply sufficient fresh air to prevent leaks from reducing the oxygen level in the cabin. However, under abnormal conditions and on the ground this may not be the case. Therefore, it is strongly believed that this warning system will be required to prevent subsequent loss of life in case of an unknown failure.

4.2.6 Flight Operations Training

Flight operations training for this purpose will consist of training requirements for both pilots and dispatchers. A general course should be administered to both sectors describing the benefits and hazards associated with nitrogen inerting systems. Also, a review of the basic fire triangle and flammability characteristics of jet fuel should be accomplished to familiarize both groups with the dangers associated with warm ullage temperatures. This will allow them to establish operational practices, such as ground air-cart usage on warm days, to control these circumstances. Dispatchers will also need to be trained to understand any dispatch deviation requirements necessary for dispatch with an inerting system inoperative. Pilot training requirements vary greatly depending on equipment type, inerting design, and operational environment. For example, a corporate pilot operating in or out of a remote airport may have greater responsibilities than a pilot may in airline type operations. A typical training program operated in-house would consist of a training bulletin followed up by a regularly scheduled module during recurrent training. Outside or contracted training would typically consist of a training program established by a commercial training facility and administered during special training events. Both would greatly benefit from an Advisory Circular provided by the FAA to assist operators with development of training materials.

4.3 GROUND OPERATIONS

Installation and operation of any inerting system will effect ground operation regardless of which inerting concept is considered. Introduction of any of the systems will add new considerations whether it be safety, new tasks, or dealing with new support equipment. Obviously the Ground Based Inerting system has the largest impact on ground operations because of the servicing requirement prior to each flight.

4.3.1 Ground Operations Safety

The safety-training course for ground operations should include the hazards of nitrogen and other inert gases. Some gases such as nitrogen are particularly insidious because of their poor warning properties.

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[4]For the GBIS see section *5.3.2 Cost to Carry* and for the OBIGGS see section *7.3.8 Cost to Carry per Airplane per Year* ($).

Oxygen-depleted environments from the inerting process have been reported to cause fatalities to workers in confined spaces. The National Institute for Occupational Safety and Health (NIOSH) has provided data from a ten-year study (NTOF data) pertaining to the number of victims in single and multiple fatalities for all types of confined-space incidents.

A startling 585 separate fatal incidents in confined spaces claiming 670 victims occurred within the 10-year study period. This data strongly underscores the need for increased ground operational safety requirements by all operators prior to introducing any inerting system. Due to the nature of this type of gas, confined areas—such as cargo bins and equipment bays—are particularly susceptible to this hazard.

The minimum recommendation of this ARAC committee is that all ground operation personnel should be aware of these dangers and know what to do in the event that something goes wrong using nitrogen to accomplish the inerting process. Airport fire, rescue, and safety personnel would also require additional training on the uses of nitrogen and confined-space rescue in airplane fuel tanks.

The possibility of over pressurizing the airplane fuel tanks is also a serious safety concern when using nitrogen to inert the ullage space of airplane fuel tanks. Having technicians who have had the recommended training perform the inerting tasks safely and efficiently should alleviate this concern.

4.3.2 Ground Operations Training

Mandatory awareness training is recommended on the dangers of using nitrogen in the quantities required to inert airplane fuel tanks. As mentioned above, an eight-hour initial program should be provided for all technicians involved with installation and servicing.

Up to a four-hour annual recurrent program is also recommended to maintain the heightened awareness on the hazards of working with nitrogen in these volumes. As an example, one hour could include a video on servicing while another hour encompasses troubleshooting and servicing. The remainder of the time can be utilized for applicable system training and open discussions. Other groups working on and around the airplane should also be aware of the dangers associated with nitrogen. These groups should receive recurrent safety training annually. These different groups should include but are not limited to cleaners, fuelers, baggage handlers, caterers, ticket/customer service agents, flight attendants and pilots. The video for example may adequately educate these individuals on the dangers and cautions involved with nitrogen inerting.

For maintenance training purposes, a $75/hour cost rate provided by the FAA, and discussed in the Estimating & Forecast Team Report (Appendix G), establishes a value for estimating an operator’s cost to have a technician install, service, and be properly trained for the continuing performance of these functions. All other group rates will vary respectively.

4.3.3 Ground Servicing

With the above-mentioned dangers of using nitrogen to inert airplane fuel tanks, ground service employees should not perform the servicing of airplane with GBI systems unless they are specifically trained maintenance technicians for the required inerting task. With the continual industry concerns with on-time performance, having the technician in place will help in facilitating that process. Numerous discussions took place on this topic and this group concluded that, after the system has been in operation for several years, reconsideration could be given on who should perform the inerting task.

Trained technicians with a through understanding of the system and the consequences of improper operation would be better prepared to monitor and interrupt the inerting process at any time for diagnosis and troubleshooting of system anomalies. To enhance on-time performance, having a technician in place will provide the operator with immediate troubleshooting capability for a system discrepancy during the inerting process, thus minimizing any ground delay due to maintenance problems associated with the inerting system. This process would require technicians in all airplane stations, and considerations should be given to contract maintenance personnel requirements at locations not staffed by operator-employed technicians.

5.0 GROUND BASED INERTING SYSTEM

This section discusses the modification of in-service aircraft to install a ground based inerting system. The overall effect of ground based inerting systems on airplane operations and maintenance requirements are also described.

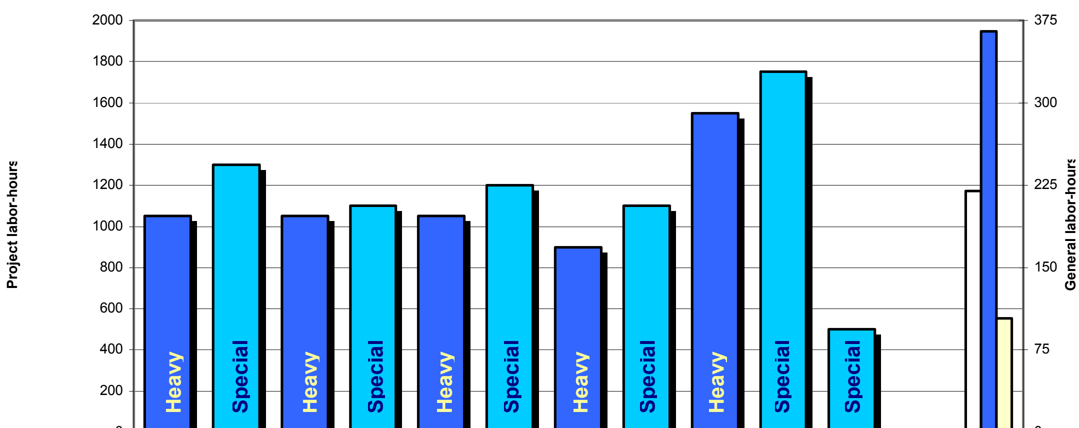
5.1 MODIFICATION

In Figure 5-1 the modification estimations for the GBIS are shown. For all airplane categories estimations were made for both a regular heavy maintenance visit and a special visit. However, for corporate and business airplanes (part 91 Operators) the modification would likely be accomplished at the factory service centers. For this airplane category there is only special visit estimates shown. A detailed table with costs and labor-hours is shown in addendum F.A.1 and F.A.2.

For the regional fan airplane types estimation for airplanes with bag-tanks (rubber cells) was made as well. The Team felt that this had to be estimated to determine how many extra man-hours would be required to do the project.

For the regional turboprop airplane types no estimation was made, because the Team could not find a company that does the maintenance for turboprop airplanes with a center wing tank. It should be noted that, Fokker Services, who did the estimates for the regional turbofan airplanes, indicated that there are very few if any turboprop airplanes that have a center wing tank.

On the left side of Figure 5-1 the project estimated labor-hours are shown for the different airplane categories. On the right side the general labor-hours are shown. These labor-hours are equal for all airplane categories. See addendum F.A.1 and F.A.2 for detailed data of the estimate.



	Large	Large	Medium	Medium	Small	Small	Regional Fan integral	Regional Fan integral	Regional Fan bagtank	Regional Fan bagtank	Business jets 1e		General
Project Time	1050	1300	1050	1100	1050	1200	900	1100	1550	1750	500		
Engineering													220
Tech. Pubs.													365
Material Control													104

Figure 5-1. Modification Estimations for Ground Based Inerting Systems

5.2 SCHEDULED MAINTENANCE

5.2.1 Scheduled Maintenance Tasks

A list of scheduled maintenance tasks was developed using the Ground Based Inerting system schematic provided by the Ground Based Inerting team. Each component illustrated in the schematic was evaluated individually and tasks were written accordingly.

These tasks included inspections, replacements, and operational/functional checks of the various components that make up the system. These tasks were assigned to the various scheduled checks (A, C, 2C and Heavy) and labor hours for each task were estimated. Figures F5.2.1-1 through Figure F5.2.1-6 (found in addendum F.B.1) lists these tasks for each of the airplane types.

It was assumed that tasks completed at a C-check, would also be completed at a 2C-check. Similar assumptions were made for the 2C-check (i.e. they would be accomplished at the Heavy check).

5.2.2 Additional Maintenance Labor-Hours

Figure 5-2 shows the estimate of additional scheduled maintenance man-hours that would be required at each check to maintain a Ground Based Inerting system.

Airplane category	Additional A-check hours	Additional C-check hours	Additional 2C-check hours	Additional heavy check hours	Average additional labor-hours per year
Business jet	2	5	7	17	16.46
Turboprop	2	5	7	17	16.46
Turbofan	2	5	15	17	17.21
Small	2	5	17	17	34.65
Medium	2	5	21	21	32.93
Large	2	5	25	25	34.74

Figure 5-2. Scheduled Maintenance Times

5.3 UNSCHEDULED MAINTENANCE

As per the tasking statements, the design basis for the GBI system is to inert fuel tanks that are located near significant heat sources or do not cool at a rate equivalent to an unheated wing tank. Hence, the design concept for the GBI system considered only center wing tanks and auxiliary tanks. Additionally, since the GBI system only operates on the ground, the system operation time was based on the average turn times. The basic design of a GBI system for airplanes without auxiliary tanks is considered relatively simple and the detailed design concept was discussed previously in this report.

5.3.1 System Reliability

For the purpose of conducting a reliability and maintainability analysis, the following system components were evaluated:

- Non-return valve
- Isolation valve with integral thermal relief valve
- Self sealing coupling incorporating a frangible fitting
- Ducting (including distribution manifold and double wall tubing)
- Wiring

For airplanes with center wing and auxiliary tanks, the system components would include the same components as a center wing tank installation with the addition of one non-return valve and one isolation valve per auxiliary tank plus interconnect ducting. The impact of including auxiliary tanks in the reliability and maintainability analysis was considered minor, as it would simply increase the quantity of non-return valves and isolation valves depending on the number of auxiliary tanks installed. This would affect the component Mean Time Between Unscheduled Removal (MTBUR) for the non-return valve and isolation valve, however the exclusion of the auxiliary tank components is considered well within the margin of error of the total system analysis. As a result, only the center wing tank components noted above were considered in the analysis.

Additionally, the need for a pressure regulating valve (PRV) that would limit the delivery pressure of the NEA on some business jets and regional airplanes due to fuel tank construction was discussed in the system design concept above. Conceptually, the PRV could be part of the airplane system or the airport delivery equipment. Because of this and the limited applicability of the PRV, this component was not considered in the analysis.

As with each of the system design concepts the component reliability was evaluated based on similar components. Once the individual component MTBUR was determined, the system MTBUR was estimated to be 9,783 hours. Because of the systems simplicity the GBI system had the highest level of reliability and is the only system with reliability levels considered acceptable for commercial airline service.

The system MTBUR was used for each of the six-transport category airplanes. There was no attempt to determine whether the system MTBUR would vary between the different categories, due to system size or operational differences. It was felt that any differences were well within the margin of error used to calculate the system MTBUR.

The system annual failure rate was then calculated based on the system MTBUR and yearly utilization rate for the respective airplane.

As discussed in the Methodology section, the annual delay time was determined based on standard delay rate assumption for each airplane type.

As described earlier, each airplane type was then looked at separately to determine component removal and replacement time, access time and troubleshooting time. The system maintenance labor hours/year were determined based on the summation of the individual component removal, replacement, access, and troubleshooting time multiplied by the component annual failure rate (Figure 5-3).

Category	Large	Medium	Small	Regional turbofan	Regional turboprop	Business
Annual failure rate	0.42	0.29	0.29	0.22	0.3	0.11
Standard delay rate (1 delay = XX min)	30	45	60	60	60	60
Annual delay time (min/year)	13	13	17	13	18	7
Unscheduled maintenance labor (hr/year)	3.13	1.96	2.02	1.35	1.89	0.77

Figure 5-3. GBI System Reliability and Maintainability Analysis

5.3.2 Cost to Carry

A cost to carry value for the GBI system was calculated based on system weights provided by the design team. System weights were provided for large, medium and small airplane types and included weights of components listed above as well other equipment that were not included in the analysis, such as brackets and ground straps. The calculated cost to carry value represents the costs associated with the additional weight of the system over one year of operation.

5.4 FLIGHT OPERATIONS

Ground based inerting has the least impact to flight operations in that there would be no on-board operating systems to monitor or control. There would only be the calculation of the quantity of NEA to on load at the ramp, which would be a dispatch/ramp office function, to be verified by the operating crew.

The object has been to design the servicing apparatus so that this function can be accomplished within the average minimum established turn times and thus not creates delays, although scheduled very short turn flights could be impacted. Very little flight crew training should be necessary, but dispatch and ramp office personnel must be proficient in calculating and verification of the procedure. Dispatch requirements need to be thoroughly established with regard to conditions of non-availability of NEA supply and the existing conditions of take off and flight from a station. Airport usage for scheduled or alternate operations will have to be evaluated and indeed route structures could be impacted by non-availability of NEA.

5.5 GROUND OPERATIONS

This group easily established the GBI system as one of the most labor-intensive of all proposed inerting methods researched to date. This is partly due to the fact that the GBI system would require that a dedicated Technician be present during the inerting process while parked on the ramp, or at the gate. The GBI system is also solely dependent on the airport infrastructure.

For the purposes of the gate operation, airplanes would undergo servicing procedures something similar as follows:

> A technician will attach the inerting hose from a dedicated source. This source may either be from the terminal (Jetway) or tanker based. After the inerting value is given, the valves are opened to allow the flow of nitrogen into the tank. At the end of the operation, the technician closes the valves completing the process. When the inerting equipment has been secured, the Technician will provide the flight crew an inerting slip. This slip will verify the flight number, date and quantity of inerting gas loaded, along with a signature of individual who performed the task. The flight crew would then check the quantities against the flight release. This would allow normal servicing and through-flight responsibilities such as log book items, and maintenance checks to be accomplished as they are in the present gate environment. Inerting times would be proportional to the type of airplane.

Inerting trucks would also be utilized at small airports and in remote areas of the airport and maintenance facilities, to allow maintenance to inert tank when the airplane is away from the gate.

The ground inerting process would be unique in that while the inerting system is not flight critical, it is one of the few aircraft systems that gives the flight crew no indication or means to verify if the process has been accomplished. The person monitoring the inerting process would be solely responsible for compliance with the inerting requirements. Because ground service positions are generally held by low skilled personnel and historically, aviation turn over rates for ground service employees vs. the Maintenance Technician is significantly higher.

As a result, the team came to the conclusion that the inerting would have to be accomplished by a trained maintenance technician. Discussion regarding the reduction in costs for labor did take place during these ARAC meetings. In the early stages of "aircraft single point refueling systems", the technician was exclusive to this work and still is in many countries. As the system became more automated and reliable, less aircraft specific personnel were able to successfully accomplish this task. The inerting process should mirror this model. It was concluded that in the future, the job function could be reevaluated, but for the initial phase, it is imperative this is performed by a technician.

5.5.1 GBI Ullage Washing Labor Estimate

The fuel tank ullage washing or inerting process is very similar to and is accomplished in parallel with the airplane fueling process. The Operations & Maintenance team reviewed the proposed ullage washing procedure and developed a labor estimate for this process. The labor estimate uses the inerting time developed for each airplane category by the GBI design team. Ten minutes was added to the inerting time for connection and disconnection of the ground service unit to the airplane and to complete the paperwork require to sign off the inerting process as completed. This resulted in an estimated amount of time for each airplane category required for a technician to inert an airplane fuel tank. These estimates were then multiplied by the number of daily operations for each airplane type and by a 30% lost labor rate to account for the mechanics non-productive time. The result is the daily and annual labor estimate for ullage washing as shown in Figure 5-4.

GBI Ullage Washing Labor						
Aircraft	**World Daily Operations**	**Inerting Time Per Turn (min.)**	**Connect/Disconnect Time per Turn (min.)**	**Lost Labor Rate**	**Labor Minutes per Turn**	**Daily Labor Hours**
Business Jet		15	10	0.3	36	
Turboprop	20,000	10	10	0.3	29	9524
Turbofan	10,000	10	10	0.3	29	4762
Small Transport	48,167	10	10	0.3	29	22937
Medium Transport	5,142	15	10	0.3	36	3061
Large Transport	4,599	20	10	0.3	43	3285
				Total Daily Labor Hours		43568
				Annual Labor Hours		15,902,355

Figure 5-4. GBI Ullage Washing Labor Estimate

Nitrogen inerting stations could be mounted on the jet-ways or terminal buildings at major airport similar to the preconditioned (PC) air systems currently in use at most major U.S. airports. The specifics of this type of system will be expanded on in the portion of the report provided by the facilities team. At airports that currently use PC air systems at the gate, the ramifications placing inerting equipment in the vicinity of these units must be considered to preclude the possibility of nitrogen from being vented into the cabin.

At major hubs during nitrogen dispensing at gate areas, the major airport hubs can utilize a Jetway system that mirrors the preconditioned (PC) air systems currently in use at most major United States airports. Individual nitrogen hoses with a central supply would be affixed to all jetways and or terminal buildings. The specifics of this type of system will be expanded on in the portion of the report provided by the facilities team. Considerations should be given though to the airports that currently have PC air in place and the ramifications of inerting while the PC air is connected to the airplane and in use.

In the event that a centralized system is not available at places such as regional or smaller airports, tanker trucks or their equivalent, would provide nitrogen to operators at these areas. Airplane size and flight schedules would determine the demand for these airports.

Procedures would also have to be established for airplanes that divert into stations that do not have sufficient nitrogen quantities for the inerting process.

Complications combined with experience requirements should also be of consideration when determining the long-term effects of having, verses not having qualified Technicians available to perform the inerting tasks. This may also hold true for the initial MEL process on through flights.

5.5.2 Potential Future System Improvements

The basic philosophy for the Ground Based Inerting system as it is discussed in this study is to supply a standard volume of nitrogen to a fuel tank prior to each flight. This standard volume would be based on the assumption of a maximum ullage space or that the tank is empty. If the tank contains a quantity of fuel, this would result in more nitrogen being used than is necessary to inert the tank. The excess nitrogen would then be discarded through the tank vent system. The philosophy satisfies the inerting requirement but results in an increased nitrogen requirement and more VOC's being released in the atmosphere. This may be a problem in some of the more environmentally sensitive areas in Europe and the U.S.

One long-range solution to this problem would be to adjust the volume of nitrogen used to inert the tank based on the amount of fuel in the tank. When the fuel load for a flight is determined the nitrogen load would also be calculated and included on the fueling sheet. This would require a change to the software used to calculate the fuel load at a one-time cost of $5000 to $500,000 per operator, depending on the kind of fuel load program used. Dispatchers would also need to be trained to determine the volume of NEA required. This was considered as a future improvement to the GBI inerting process and therefore these costs are not taken into account in the modification estimations.

Further possibilities for future system improvements could include an on-board inerting computer. The inerting computer would provide the maintenance Technician the means to select a specific tank and fuel quantity. Once the information is entered, the computer calculates the proper inerting value for that tank. A monitoring function keeps the technician aware of any inerting anomalies. Sensors automatically close the inerting valves when the process is complete. Once the servicing door is closed, the computer could provide also provide a signal to the flight deck in case of inerting discrepancies or system. Built in test equipment at the panel could also allow Technicians to test line replaceable units and perform maintenance checks. Such a system may streamline the inerting process.

6.0 ON-BOARD GROUND INERTING SYSTEM

This section discusses the modification of in-service aircraft to install an On-Board Ground Inerting System. The overall effect of OBGIS on airplane operations and maintenance requirements are also described.

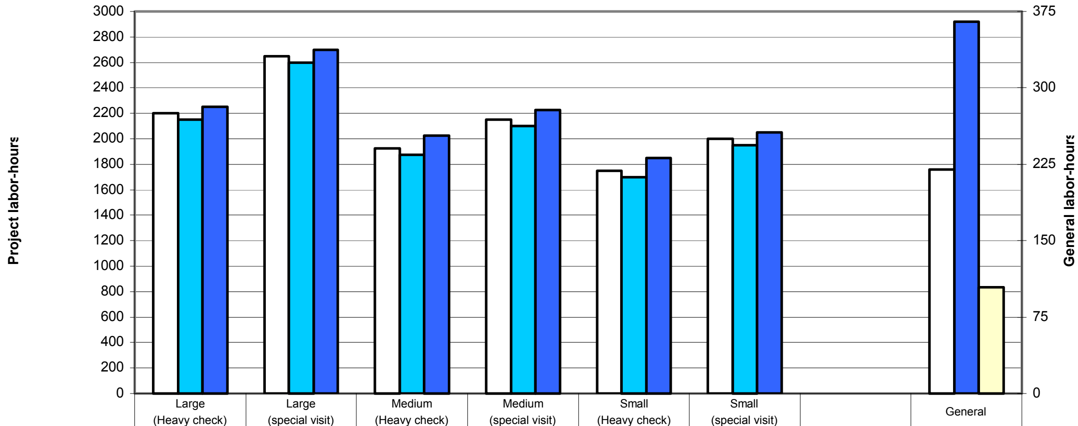
6.1 MODIFICATION

In Figure 6-1 the modification estimations for the OBGIS are shown. Due A survey of regional and business jet aircraft indicated that insufficient space is available to accommodate an OBGI system in the unpressurized areas these category airplanes. As a result these airplanes have been excluded from this estimate. Estimations are made for both a regular heavy maintenance visit and a special visit.

The modification estimations for the OBGIS are based on the estimations of the OBIGGS, however since the OBGIS are only designed for the center wing tank and auxiliary tanks the labor estimates have been reduced to account for installation differences. The following reductions are used:

- For the large airplane category: 300 man-hours
- For the medium airplane category: 250 man hours,
- For the small airplane category: 200 man-hours.

On the left side of Figure 6-1 the estimated modification labor-hours per aircraft are shown for the different airplane categories. On the right side the general support labor-hours are shown. The support labor-hours are incurred on a per operator basis as opposed to per aircraft and are approximately the same for all airplane categories. See addendum F.A.1 and F.A.2 for detailed data of the estimate.



	Large (Heavy check)	Large (special visit)	Medium (Heavy check)	Medium (special visit)	Small (Heavy check)	Small (special visit)		General
Membrane	2200	2650	1925	2150	1750	2000		
PSA	2150	2600	1875	2100	1700	1950		
Cryogenic	2250	2700	2025	2225	1850	2050		
Engineering								220
Tech. Pubs.								365
Material Control								104

Figure 6-1. Modification Estimations for On-Board Ground Inerting Systems

6.2 SCHEDULED MAINTENANCE

6.2.1 Scheduled Maintenance Tasks

A list of scheduled maintenance tasks was developed using the On Board Ground Inerting system schematic provided by the On-Board Design team. Each component illustrated in the schematic was evaluated individually and tasks were written accordingly. These tasks included inspections, replacements, and operational/functional checks of the various components that make up the system.

Tasks were assigned to the various checks (A, C, 2C, and heavy) and labor-hours for each task were estimated. Figures F6.2.1-1 through Figure F6.2.1-6 (found in addendum F.B.1) contain a complete list of these tasks. The team assumed that tasks completed at a C-check would also be completed at a 2C-check. Similar assumptions were made for the 2C-check (i.e., they would be accomplished at the heavy check).

The OBGIS consists of several more components than the GBIS. Thus, additional tasks are required, substantially increasing the additional labor-hours required in the 2C- and heavy checks.

Because the size and complexity of the onboard ground inerting (OBGI) concept made the system infeasible for turbofan, turboprop, and business jet category airplanes, analysis was not completed for these airplanes.

6.2.2 Additional Maintenance Labor-Hours

Figure 6-2 below shows the estimate of additional scheduled maintenance man-hours that would be required at each check to maintain an On Board Ground Inerting system.

Airplane category	Additional A-check hours	Additional C-check hours	Additional 2C-check hours	Additional heavy check hours	Average additional labor-hours per year
Small	3	4	18	51	50.55
Medium	3	4	18	55	48.31
Large	3	4	18	59	46.51

Figure 6-2. Scheduled Maintenance Times

6.3 UNSCHEDULED MAINTENANCE

The OBGIS which consists of approximately 26 major components is significantly more complex than the GBIS,. Like the full OBIGGS, the airplane system is self-sufficient, which is the reason for the increased complexity.

6.3.1 System Annual Utilization Rate

Although the Onboard Ground Inerting System equipment is very similar to the full OBIGGS system, the operating philosophy is significantly different. Unlike OBIGGS the classic On-board Ground based Inerting system operates only while the airplane is at the gate. Therefore the operating time on the OBGI system is significantly less than for full OBIGGS over the same period of time reducing the wear & tear on system components. To account for the reduced operating time the System Annual Utilization rate for OBGI is based on the typical gate time and number of daily operations for each category airplane.

Airplane category	Aircraft usage rate, flight-hours/year	OBGI system operational time, hours/year
Large transport	4,081	1,095
Medium transport	2,792	1278
Small transport	2,869	1,916
Regional turbofan	2957	1080
Regional turboprop	2117	1034
Business jet	500	365

Figure 6-3. OBGI System Annual Utilization Rate

6.3.2 System Reliability

As with the unscheduled maintenance analysis on the other system concepts the reliability of the On-board Ground Inerting systems components was primarily based on a comparison to similar components currently in use on commercial airplane. The tables in Addendum F.C.2 show the estimated MTBF and MTBUR for individual system components. The significant decrease in the reliability level of the OBGI system as compared to the Ground Based Inerting system is due to the increased complexity of the system. The increase in the number of parts and the introduction of lower reliability, higher maintenance components such as compressors and air separation modules decreases the system reliability by a factor of 10 times. The OBGI system Mean Time Between Unscheduled Removals was calculated to be 945 hours for the PSA system and 960 hours for the membrane system. The difference between the systems is due to the slightly higher reliability of the membrane air separation module.

Because similar component reliability data for a range of component sizes was not available the analysis assumes that the reliability of the OBGI system is the same for all sizes of airplane. In reality system reliability may vary with the systems size but the purposes of this study the variation is assumed to be well within the margin of error for the reliability estimate.

6.3.3 System Annual Failure Rate

The annual failure rate for the inerting systems is a function of its reliability (MTBUR) and the System Annual Utilization rate. Using OBGI system Annual Utilization rate, the frequency of inerting system failures on each airplane was predicted to be approximately two failures per year for an OBGI system.

The system annual failure rate is significant because it is an indicator of how maintenance intensive the inerting system is and what the level of impact the system will have on flight operations. In the case of the OBGI system an operator with a fleet of 300 airplanes could expect to have to address 600 additional maintenance problems per year due to the inerting system.

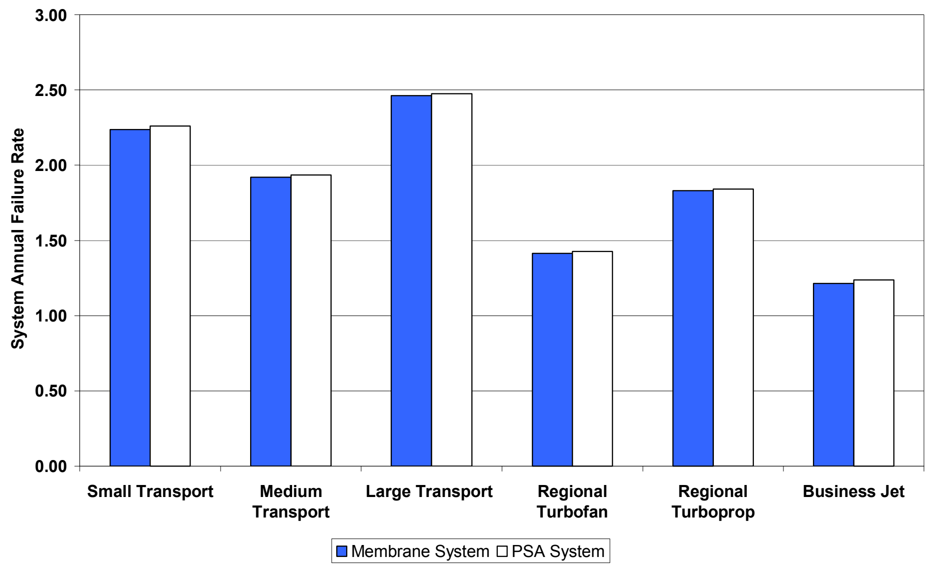


Figure 6-4. Predicted OBGI System Annual Failure Rate

6.3.4 Unscheduled Maintenance Labor Estimate

As with other system concepts, a survey of potential component locations was done for each of the category airplane. Based on this survey, estimates were developed for troubleshooting, removal and installation of each component. The tables in Addendum F.C.2 detail the troubleshooting, removal and installation labor hour assumptions. Probable component locations, size and weight were considered in developing this estimate. The labor estimate and the components predicted failure rate were used to estimate annual unscheduled maintenance labor rate for the OBGI system on each airplane type and is summarized below.

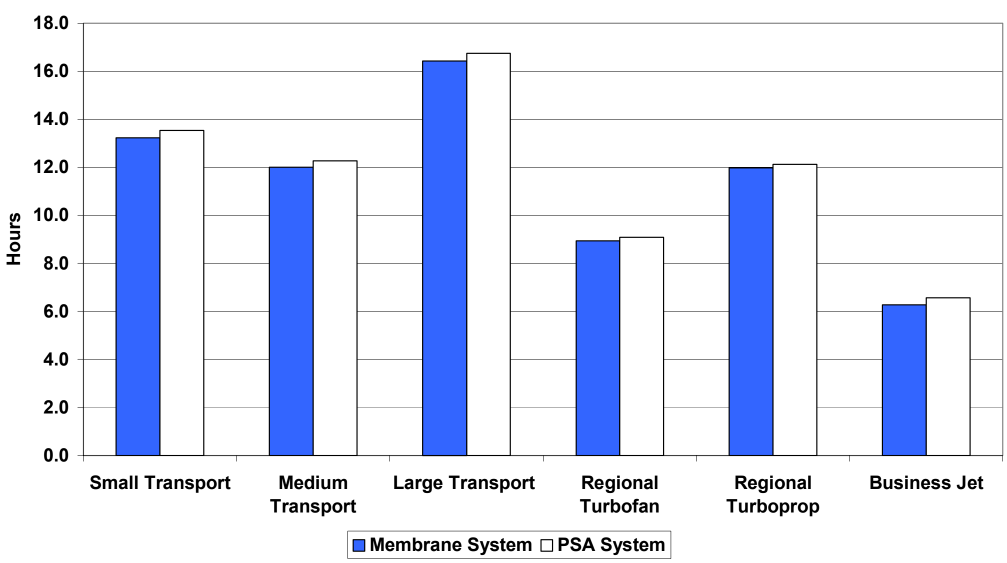


Figure 6-5. Annual Unscheduled Maintenance Labor Estimate per Airplane

6.3.5 Inerting System Availability

The availability of an OBGI system is a function of the system reliability and the repair interval assumed for MEL dispatch relief. For example, if the system has an annual system failure rate of 2 failures per year and the MEL dispatch relief allows a 3 day repair interval the inerting system maybe assumed to be inoperative 6 days per year. Another way to look at system availability is as a percentage of departures. If the airplane typically has 7 departures per day as the small transport does, then the airplane would depart on 42 flights per year out of 2555 with the inerting system inoperative. Assuming that an inerting system would remain inoperative for the maximum allowable number of days is a worst-case scenario. In reality, the systems would likely spend 50-75% of the allowable time on MEL, but for the purposes of this study, it is assumed that the full repair interval is used all the time. When considering the effect of the number of days a system is allowed to remain on MEL that decreasing the number of days improves the system availability but comes at a cost in terms of increased flight delays, cancellations, and operating costs.

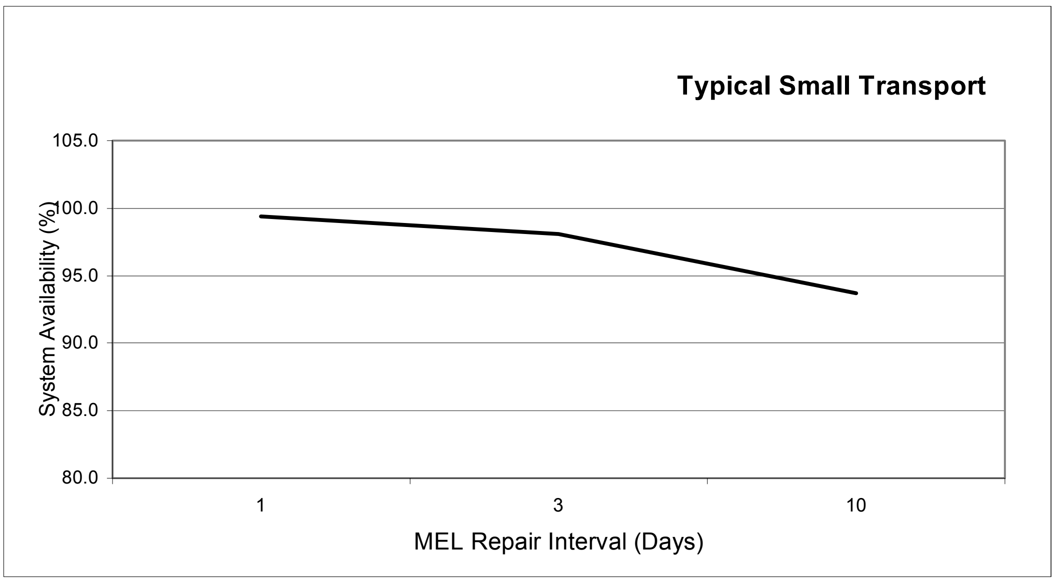


Figure 6-6. Impact of MEL Relief on System Availability

Figure 6-7 shows the expected OGBI system availability for each category aircraft based on 10 day MEL relief availability.

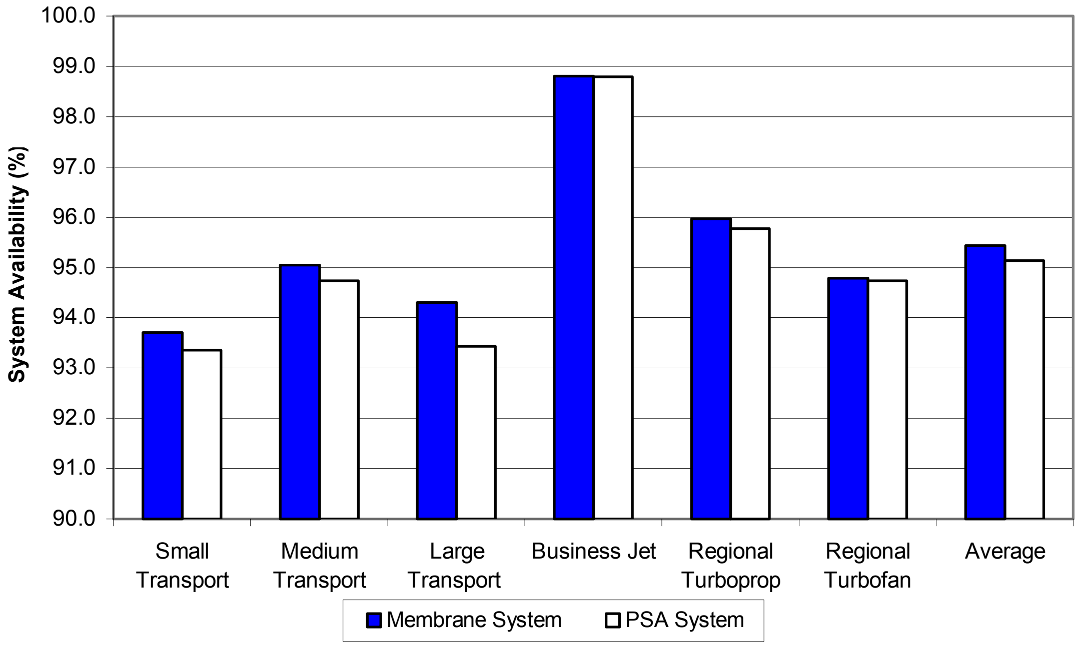


Figure 6-7. OBGI System Availability

6.3.6 MEL Dispatch Relief Effect

The effect of the MEL dispatch relief assumption is discussed in detail in Section 10 of this report. The availability of MEL dispatch relief for none critical aircraft systems and the length of time allowed before the system must be repaired has a large impact the airplanes dispatch reliability and cost of operation. As an illustration the number of delays and cancellations an operator might experience for a typical small transport airplane equipped with an OBGI system was calculated. This estimate is based on the projected OBGI system annual failure rate and some assumptions about the frequency of delays and cancellations based on a system failure.

If no MEL dispatch relief is available there is a high probability the system failure would result in multiple flight cancellations. If dispatch is available the likelihood of flight delays and cancellations decreases as more time is allowed to route the aircraft to a location were maintenance is available. The system can then be repaired during an overnight maintenance visit. The specific assumptions used here are based on typical operator experience and are presented in Appendix F.

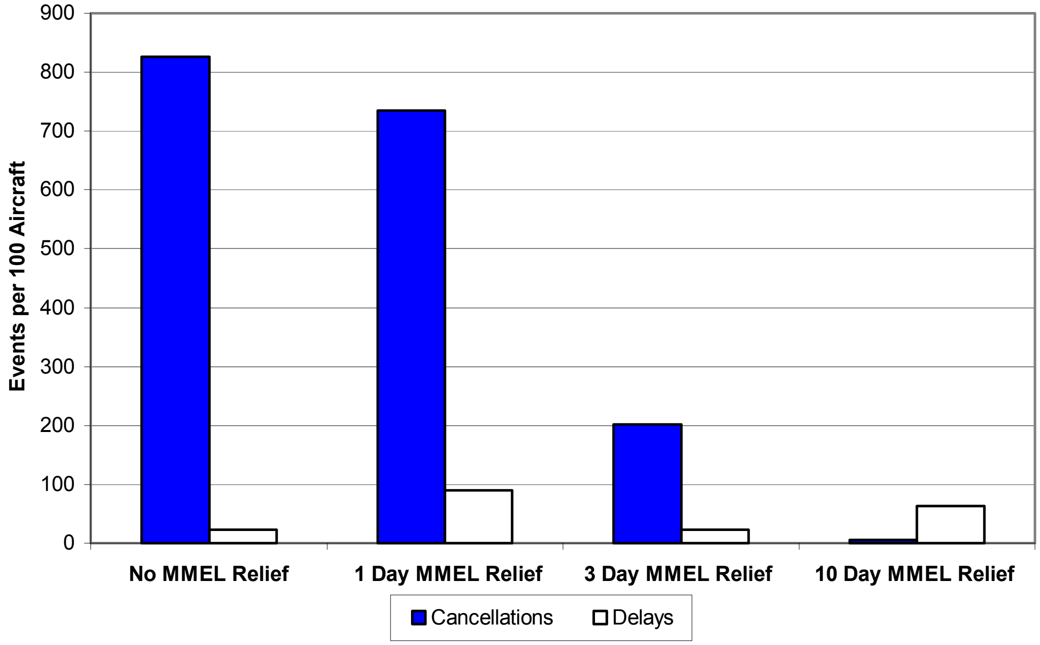


Figure 6-8. MEL Dispatch Relief Effect

6.3.7 Delay Hours per Year

An estimate of the effect of inerting system failures on flight departure schedules was made based on the OBGI systems annual failure rate. The delay assumptions used for this estimate were discussed earlier under the "Flight Delay" analysis methodology; section 2.4.3. Although not every system failure causes a delay, it is equally true that a single maintenance delay frequently causes multiple down line delays due to a cascade effect in the daily flight schedule. The number of delays and delay hours per year effect customer service. The airlines, through experience have determined the impact of the reduction in customer satisfaction due to delays on operational revenue. Flight delays also effect operating costs through schedule changes, down line flight cancellations, and lost passengers.

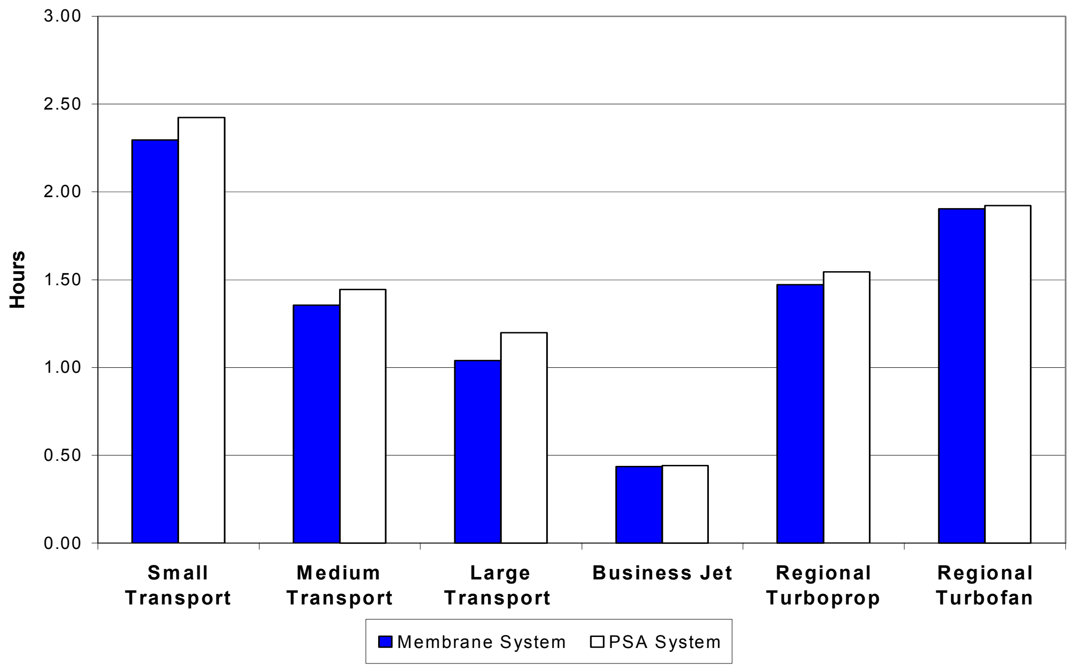


Figure 6-9. Annual OBGI System Flight Delay Hours

6.4 FLIGHT OPERATIONS

The on-board ground inerting system allows for the availability of NEA for ground inerting techniques to be employed at any airport that the airplane is deployed to if an adequate electric power source is available. The system is designed to have adequate output to preclude delays beyond what are considered average turn times for that airplane. The system is designed to require minimal activation and supervision by the flight crew with little or no cockpit instrumentation and a simple on/off switch being redundant to automatic activation. Training for flight crew would be mostly educational to the system protections and functions and characteristics. Since it is largely automatic and if inoperative there would be additional training for crew and dispatchers in MEL provisions in order to allow dispatch of the airplane if repair is not possible at a station. The system should be designed to be failsafe so that no hazard is presented by its operation to passenger or ground personnel.

A moderate weight penalty is incurred in carrying this system on board and manifested in additional fuel burn. However, there is no power drain requirement during flight.

6.5 GROUND OPERATIONS

Both GBIS and OBGIS are operating only on the ground. The major difference between GBI and OBGI is that inerting with the OBGIS is accomplished without the requirement for additional airport facilities, except for additional ground-power requirements. The OBGIS is a self-contained airplane system.

Maintenance training requirements should be incorporated within the initial training programs similar to those discussed earlier, but tailored to this specific design. One of the concerns that differ from the GBI is that the OBGIS would require constant monitoring, particularly while fuel tanks are being inerted before the first flight of the day. The system design is such that the systems will have to be turned on 2 hr before the first flight of the day. Once power is put on the airplane and the inerting system is turned on, a normal safety procedure requires that a maintenance technician must monitor the airplane for problems. This does not necessarily mean that an maintenance technician must sit in the cockpit, but someone must be close enough to respond to alarms or other problems. Activation and monitoring the airplane an hour earlier than is currently required adds a significant work to line maintenance during an already busy time of day.

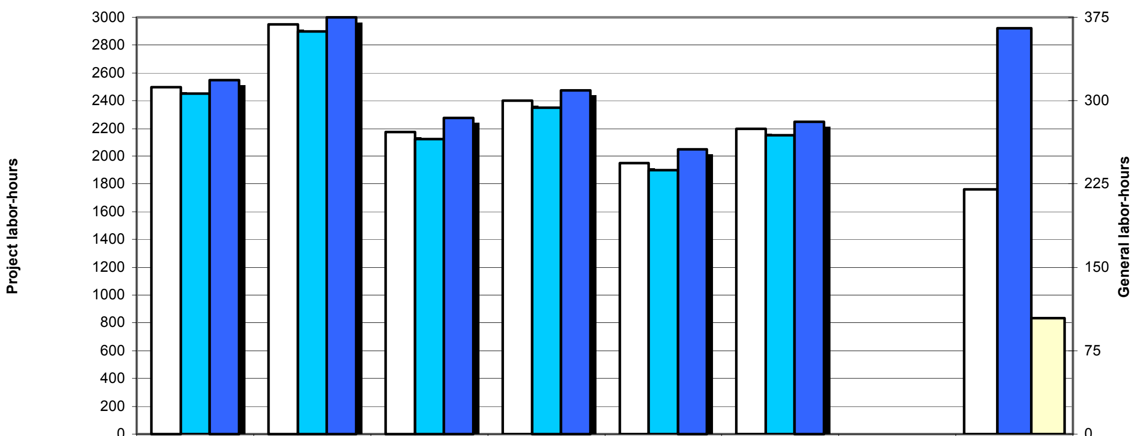
Other added responsibilities would be to ensure that the cabin is ventilated properly to ensure there is no possibility for a buildup of nitrogen in the cabin. These tasks would typically be the responsibility of the remain overnight technician. In the event a flight crewmember is not available, then a qualified technician should also monitor the inerting process during all through-flights. All other maintenance concerns typically go hand in hand with the concerns mentioned earlier with the GBIS.

7.0 ON-BOARD INERTING GAS GENERATING SYSTEM

This section discusses the modification of in-service aircraft to install an On-Board Inert Gas Generating System. The overall effect of OBIGGS on airplane operations and maintenance requirements are also described.

7.1 MODIFICATION

In Figure 7-1 the modification estimations for the OBIGGS are shown. Due to insufficient space for the OBIGGS in the unpressurized areas of regional fan, regional prop, and business jet category airplanes, these airplanes have been excluded from this report. For the other airplane categories estimations are made for both a regular heavy maintenance visit and a special visit. A detailed table with costs and labor-hours is shown in addendum F.A.1 and F.A.2.



	Large (Heavy check)	Large (special visit)	Medium (Heavy check)	Medium (special visit)	Small (Heavy check)	Small (special visit)		General
Membrane	2500	2950	2175	2400	1950	2200		
PSA	2450	2900	2125	2350	1900	2150		
Cryogenic	2550	3000	2275	2475	2050	2250		
Engineering								220
Tech. Pubs.								365
Material Control								104

Figure 7-1. Modification Estimations for On-Board Inerting Gas Generating Systems

After installation of the OBIGGS systems it may be required to do an operational test flight. These test flight costs are not taken into account in the estimations.

7.2 SCHEDULED MAINTENANCE

7.2.1 Scheduled Maintenance Tasks

Concepts for two types of On-Board Inert Gas Generating Systems (OBIGGS) were developed, and considered separately by the Scheduled Maintenance sub-team. A list of scheduled maintenance tasks for an On-Board Inert Gas Generating Cryogenic System and for an On Board Inert Gas Generating Membrane System was developed using the system schematics provided by the On Board Design team. Each component illustrated in the schematic was evaluated individually and tasks were written accordingly. These tasks included inspections, replacements, and operational/functional checks of the various components that make up the system. These tasks were assigned to the various checks (A, C, 2C and Heavy) and labor hours for each task were estimated. Figures F7.2.1-1 through Figure F7.2.1-6 (found in addendum F.B.1.) lists these tasks for each of the airplane types.

It was assumed that tasks completed at a C-check, would also be completed at a 2C-check. Similar assumptions were made for the 2C-check tasks (i.e. they would be accomplished at the Heavy check (or 4C-check equivalent)).

Both of the OBIGGS concepts consist of unique components, which require additional tasks when compared with the GBI and OBGI systems. Thus, additional tasks are required, substantially increasing the extra man-hours required in the C, 2C and Heavy checks.

Due to the size and complexity of the OBIGGS concept, analysis was not completed for Turbofan, Turboprop, and business jets category airplanes.

7.2.2 Pressure Check

Extra labor-hours have been added to each C-check and Heavy check to perform a fuselage pressure decay check and rectification. OBIGGS uses cabin air as a supply for the inerting system, which increases the demand on the airplane air-conditioning packs. Consequently, the maximum allowable cabin leakage rate will have to be maintained at a lower level to ensure that the airplane air-conditioning packs will be able to continue to maintain the required cabin pressurization.

7.2.3 Additional Maintenance Labor-Hours

Figure 7-2 below shows the estimate of additional scheduled maintenance man-hours that would be required at each check to maintain a On-Board Inert Gas Generating Cryogenic System. And similarly, Figure 7-3 below shows the estimate of additional scheduled maintenance man-hours that would be required at each check to maintain an On-Board Inert Gas Generating Membrane System.

Airplane category	Additional A-check hours	Additional C-check hours	Additional 2C-check hours	Additional heavy check hours	Average additional labor-hours per year
Small	3	55	74	87	124.03
Medium	3	55	74	91	126.03
Large	3	55	74	95	115.52

Figure 7-2. Cryogenic System—Scheduled Maintenance Times

Airplane category	Additional A-check hours	Additional C-check hours	Additional 2C-check hours	Additional heavy check hours	Average additional labor-hours per year
Small	3	50	65	76	113.96
Medium	3	50	65	80	114.58
Large	3	50	65	84	105.77

Figure 7-3. Membrane System—Scheduled Maintenance Times

7.3 UNSCHEDULED MAINTENANCE

The full OBIGGS inerting system is the most complex system of all the design concepts studied. The characteristics that make OBIGGS different for other systems studied from a reliability and maintainability standpoint are its size and its operating time.

Because OBIGGS operates during all phases of flight it has an additional effect on other airplane systems. The demand the inerting system puts on the airplane electrical power generation, cabin pressurization and engine bleed air systems will reduce the reliability and increase the maintenance requirements for these systems.

The larger size and weight of the components in the OBIGGS system will make performing maintenance more difficult and in some cases may create an additional safety risk when lifting of the components during removal and installation.

7.3.1 System Annual Utilization Rate

The system annual utilization rate for OBBIGS reflects the amount of time that any of the systems would operate in one year. This figure was calculated from the airplane daily utilization rate plus the minimum turn times, multiplied by the number of daily cycles. The Large transport airplane with a high daily rate had the highest system annual utilization rate, the small transport coming a close second due to its high daily cycles.

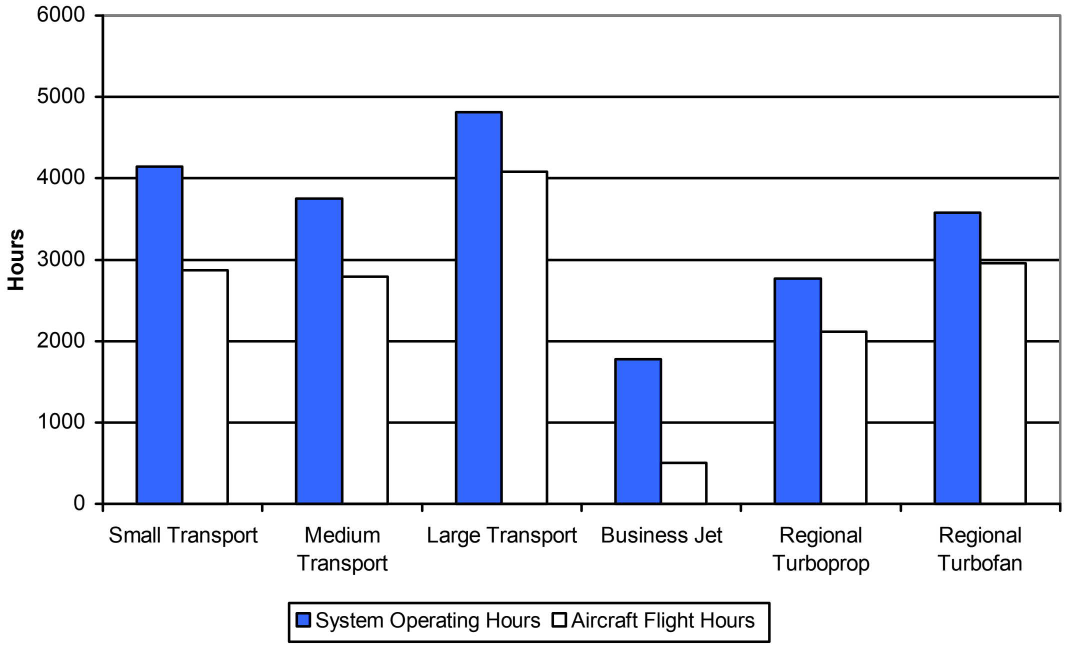


Figure 7-4. System Annual Utilization Rate

7.3.2 Component Reliability

To estimate the impact and related costs associated with the operation & maintenance of an OBIGGS system it was necessary to first establish a likely system reliability figure. From the system design it was possible to compile a list of components for each system. In most cases it was possible to use historical data from similar components to suggest a OBIGGS component mean time between unscheduled removal MTBUR. Where possible, more than one similar component was used.

One example of component reliability calculation was the OBIGGS shutoff valve. This valve would typically be a motorized butterfly type valve, which is to be found in many positions on different airplanes. Several similar valves were identified and using the historical component MTBUR data from more than one operator an average MTBUR figure was calculated. The OBIGGS design team suggested an MTBF of 50,000 hrs, the average MTBUR figure was in fact calculated at 38,315 hrs. This differential was expected and indeed confirmed that this method of MTBUR calculation was valid

Where insufficient historical data was available, a mean time between failure MTBF figure, set by the system design team, or a most likely figure, based on team members experience, was used.

Establishing the component reliability in the form of a MTBUR figure was crucial in determining the system reliability and in enabling the Team to determine not only the component and system annual failure rate but also overall impact on airplane maintenance and operations that result from system failures.

- System Weight
- Cost to carry per airplane per year ($)
- System Availability (driven by no of days MMEL. relief)
- Delays Per Year (Hours)
- Delay Costs Per Airplane Per Year ($) and
- MMEL relief ranging from none to 120 days.

7.3.3 System Reliability

The MTBUR for the system was then determined from the individual component estimates.

An effort was made to determine the difference in MTBUR between airplane categories. Where there was sufficient component data available we found that there was little difference in MTBUR's between the different airplane sizes. It was felt that it did not prove to be a significant factor in further calculations. Therefore with the resources available these figures were not developed further.

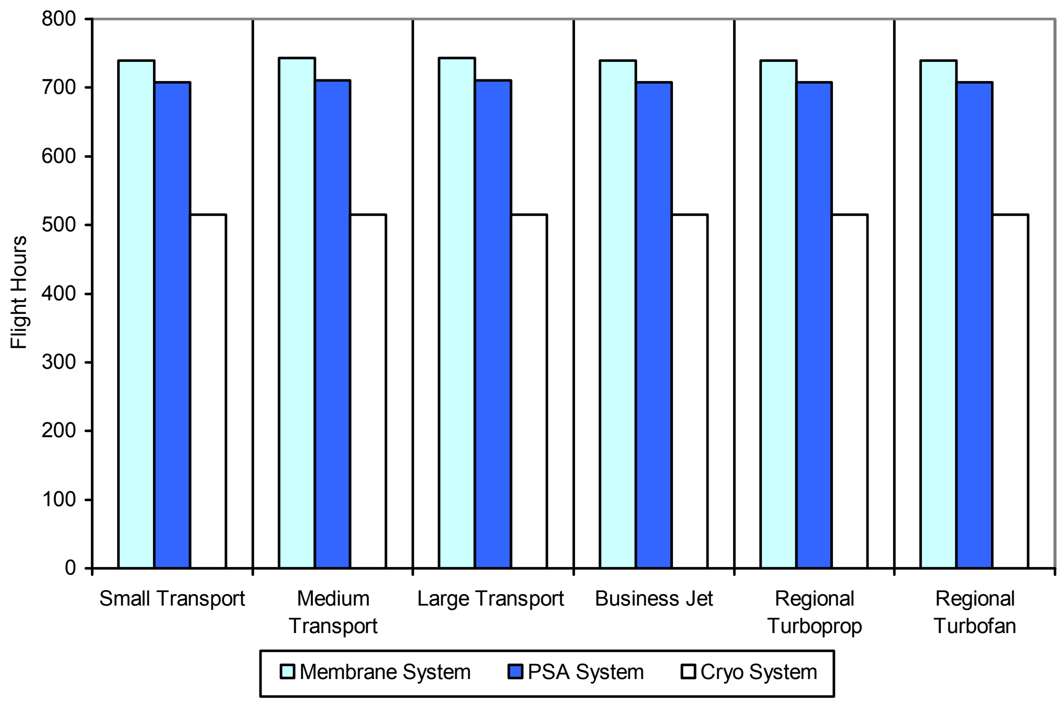


Figure 7-5. System MTBUR

7.3.4 System Annual Failure Rate

Using the component MTBURs and the airplane yearly utilization rate the annual failure rate for each component was calculated. The system annual failure rate was the sum of these component annual failure rates.

As expected due to the increased system complexity and the maturity of the cryogenic a PSA system technology, the OBIGGS system has a much higher predicted failure rate. This calculation was crucial for many further calculations such as the system availability and the effects of different MMEL repair periods.

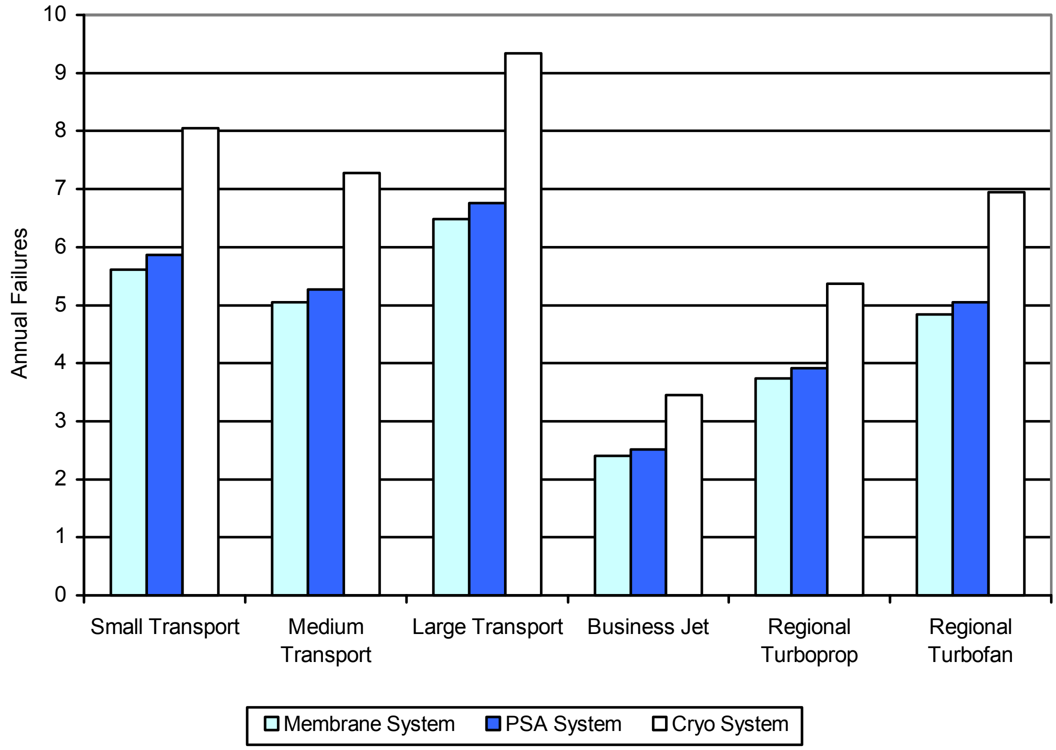


Figure 7-6. System Annual Failure Rate

7.3.5 Unscheduled Maintenance Labor Estimate

The amount of additional workload an OBIGGS system would add to an airplane maintenance requirements is a function of the annual failure rate and the component maintenance time, which in turn is a combination of the following:

- Component Removal & Replacement Time
- Component Access Time
- Trouble-Shooting Time

To calculate the labor hours per year some assumptions have been made as to the locations of the components. For example the heaviest components would be located in areas that would allow access with lifting equipment, e.g., air conditioning bay or wing to body fairing areas. Each component was individually assessed and the time to troubleshoot, access and remove and replace estimated based on similar tasks on existing airplanes.

The figures calculated refer only to the hours taken to rectify OBIGGS failures. It does not take into consideration the additional hours to maintain other airplane systems that are required to support OBIGGS (i.e. electrical or pneumatic systems) or systems effected by OBIGGS (i.e., cabin pressurization).

These figures may appear to be minimal but where an operator has many airplanes arriving and departing within a short period of time existing staffing levels may not be able to perform the rectification tasks and additional staff will need to be recruited. This additional manpower requirement is very difficult to quantify and has not been included. Therefore, the labor hour estimate is presented as an indicator of the requirement for an increased number of maintenance technicians.

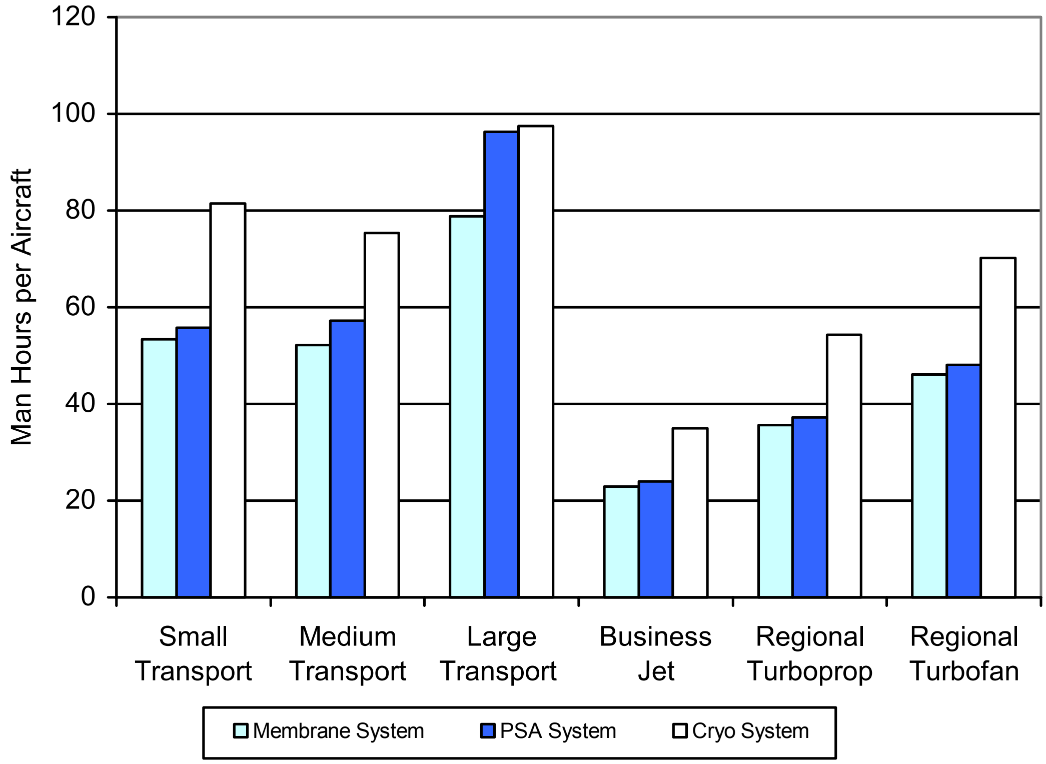


Figure 7-7. Additional Annual Labor Hours

7.3.6 Annual Labor Costs

This is a product of the additional unscheduled labor hours per year and the FAA's standard burdened labor rate for airplane maintenance technicians of $75/ hour

The costs shown are for the additional labor hours only. Operators may have to hire additional staff to fulfill these requirements, resulting in an increased financial burden for recruitment, administration and training of the required staff.

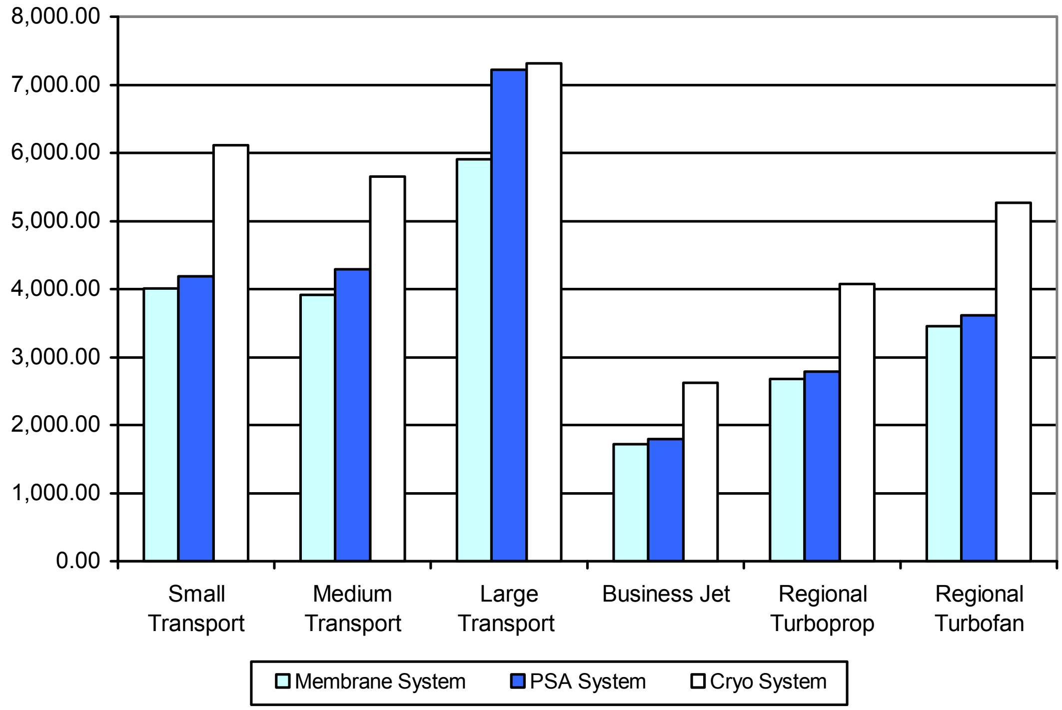


Figure 7-8. Additional Annual Labor Costs ($)

7.3.7 System Weight

System weight has been calculated from the sum of the component weights specified by the design teams. The additional weight of the system installed on an airplane will not be limited to just the additional components. This estimate does not include the added weight of structural modifications to support heavy components.

Many operators are trying hard to reduce the weight of their airplanes in an effort to achieve best economy.

This system weight has been used to calculate the cost to carry per airplane per year ($)

7.3.8 Cost to Carry per Airplane per Year ($)

The cost to carry value is a figure given just to carry the additional weight of the system on an airplane for one year and represents the additional fuel burn. It is calculated from the system weight and a variable input, Cost To Carry Per lb. Per Year $.

7.3.9 System Availability

System availability is a product of System Annual Failure Rate and the variable input, MMEL repair interval. For example, if the system has a failure rate of 5 times per year and has 10 days MMEL relief the worst case scenario could mean that it is inoperative for 50 days per year or 14% of the time. This would result in a system availability rate of 86%.

As mentioned earlier in this report the potential impact of three-day and ten- day MEL repair intervals were evaluated. Because system repairs are frequently accomplished in less time then the allowed per the MEL repair interval limits, assumptions were made concerning the average amount of time an inerting system would be inoperative under MEL relief. Under the two-day MEL relief repair interval it is assumed that the average system would be inoperative for 2 days. For the ten-day MEL relief repair interval the average system would be inoperative for 7 days.

The complexity of OBIGGS and the immaturity of both the PSA & Cryogenic inerting technology result in a relatively high System annual failure rate, which drives the system availability rate down. Information from the Safety Analysis Team suggested a system availability of 97.5% is desired to ensure that the predicted benefits of the concept are ensured. On most OBIGGS systems, to achieve over 97% availability an MMEL repair interval of 1 day is required but will seriously impact airline operations.

The chart below shows a comparison of the system availability of the membrane system with one, three and 10 days relief.

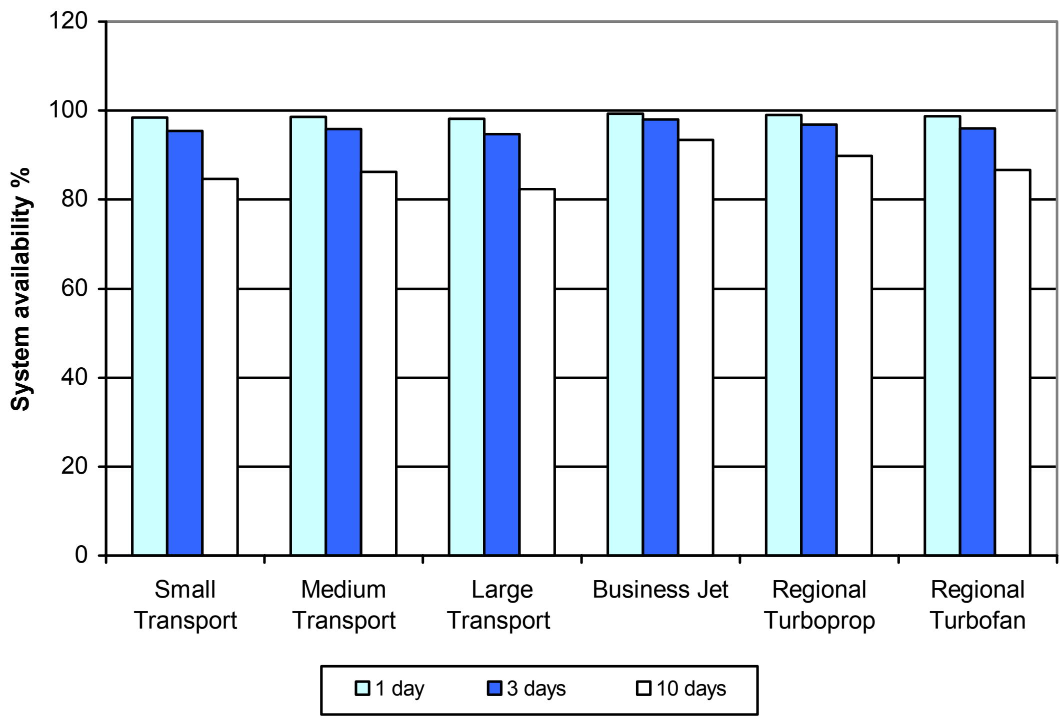


Figure 7-9. System Availability (10 Days MMEL Relief)

7.3.10 Delays per Year (Hours)

This figure has been arrived at by making a Delay Assumption that if an airplane has a fault in the system it will take a period of time for the mechanics to assess the situation, perform any maintenance action in accordance with the MMEL and complete any paperwork. Each airplane type has a delay assumption value which when multiplied by the component annual failure rate results in a total time delay for each component. The sum of the component delays results in the total annual system delay time, (hours).

World reliability figures are measured against delays and cancellations. Customers are often driven by such figures and operators make every effort to ensure on time departures. Such delays and cancellations not only directly effect operators with costs of customer accommodation and remuneration but loss of repeat custom and reputation are effected.

The causes of such delays and cancellations are actively pursued by operators with a view to reducing them to the minimum, adding another system to the airplanes which could effect such figures is of great importance to operators.

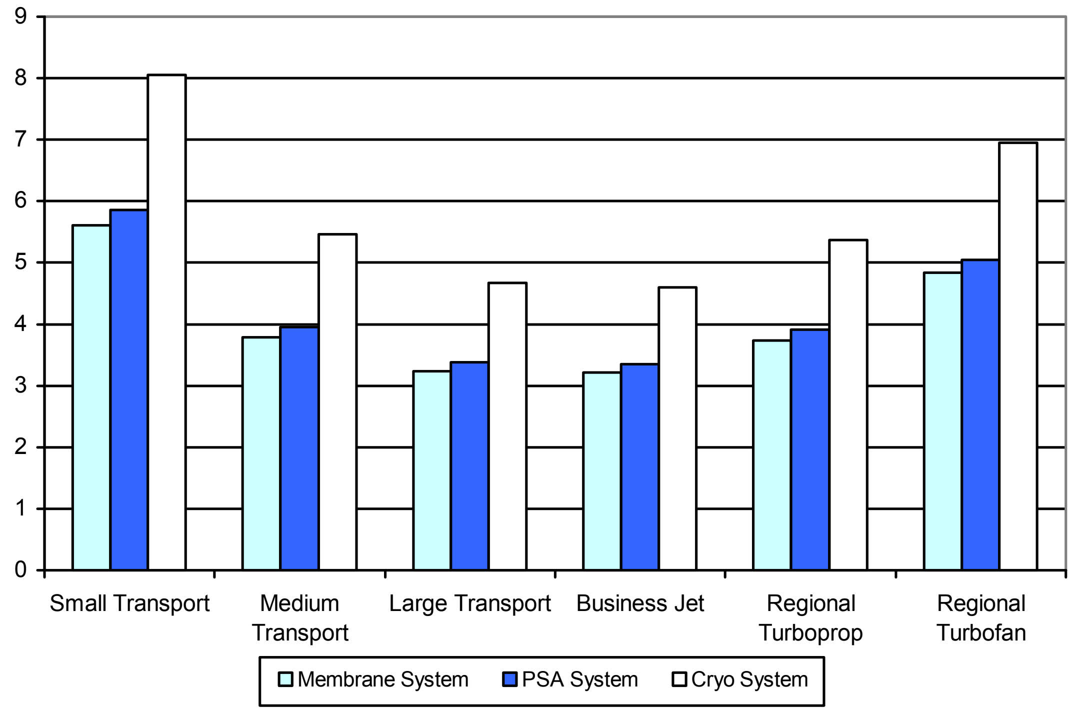


Figure 7-10. Delays per Year (Hours)

7.3.11 MMEL Repair Period

It was possible to estimate the financial effects of the different MMEL repair periods.

The repair periods studied include one, three and ten days relief. As previously discussed a one day repair period will result in the fleet system availability average being above 98%, three days would be 95.5% and ten days would mean a fleet system availability of 85.1%

It was necessary to presume what percentage of the annual failure rate would result in cancellations and correspondingly delays. These were judged accordingly with the different MMEL repair periods. These percentages can be seen in the chart below.

As an example: for the small transport airplane with a one day repair period 20% of the annual system failures will result in cancellations and 80% of failures will result in a delay equal to the delay assumption.

MMEL Repair Interval/ Service Cancellation			
	1 day	3 days	10 days
Small Transport	20%	5%	3%
Medium Transport	18%	4%	2%
Large Transport	15%	3%	1%
Business Jet	18%	4%	2%
Regional Turboprop	20%	5%	3%
Regional Turbofan	20%	5%	3%

Figure 7-11. MMEL Repair Interval/Service Cancellations (%)

7.3.12 Cancellation/Delay Costs

Operators quantify cancellations and delays at rates that were deemed as propriety information but the figures used were agreed as a good representation of the costs involved and is shown in the chart below.

Cancelation / Delay Costs $		
	Cancellation $ per event	Delay $ per hour
Small Transport	$7,600	$6,000
Medium Transport	$20,000	$8,490
Large Transport	$32,600	$10,980
Business Jet	$7,600	$6,000
Regional Turboprop	$7,600	$6,000
Regional Turbofan	$7,600	$6,000

Figure 7-12. Cancellation/Delay Costs

The following chart shows the predicted relationship between the MMEL repair period and the cancellation and delay costs for the membrane system only across the six airplane types. Where a cancellation is experienced it is presumed that half of the flights for that airplane for that day will be lost. This was felt appropriate for all airplane types except the large transport airplanes where both of the flights for that day will be lost. The figures reflect this assumption accordingly.

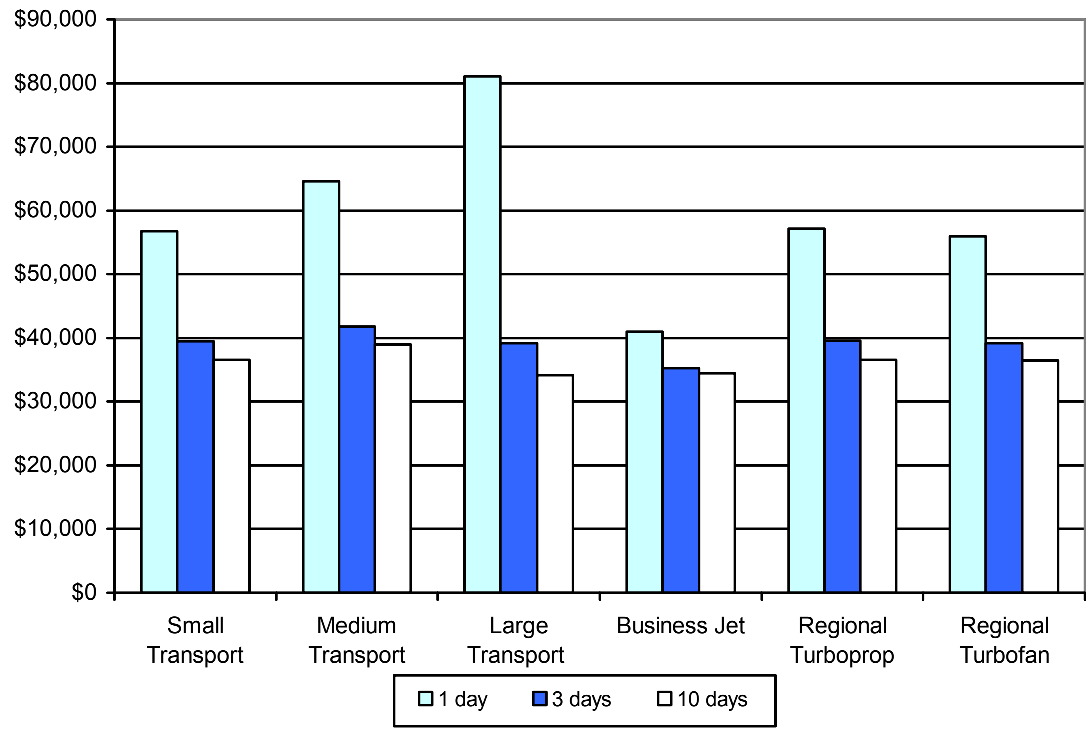


Figure 7-13. Comparisons of Costs and Repair Intervals

7.3.13 Personnel Safety

It is a major concern, for the operators and ground service agencies that by installing an inerting system the safety of personnel could be threatened. The danger to personnel entering confined spaces that could be contaminated with NEA is a real possibility. With an OBIGGS system that is operating all the time the airplane is in service and the possibility of the NEA atmosphere remaining in confined spaces after service it is a very real possibility that this system could damage or take more lives that it is intended to save. In most developed countries health and safety legislation is adhered to lot of the time but in designing a system that reduces oxygen in some of the airplane confined spaces we could be building a trap for people to fall into.

Another major concern is the size and weight of some of the components in the various systems. These range from lightweight valves and other components to heavy compressors, heat exchangers, cryocoolers and air separation modules. These range in weight from 100 lbs. to over 225 lbs. There is a recognized need for specialist lifting equipment but the risk of damage and injury from falling heavy components would exist where it previously did not.

7.3.14 OBIGGS Effects on Other Airplane Systems

The installation of an OBIGGS system on an airplane will effect the reliability and cost of operation for other airplane systems. The OBIGGS system concepts studied by this working group would add a very large additional electrical load on the airplane electrical system. The OBIGGS system also relies on the airplane pneumatic system as a supplemental air supply increasing the demand on this system. Last but not least in an attempt to reduce the size and power requirements of the OBIGGS air compressors the design team chose to take the systems supply air from the passenger cabin. This will put an additional demand on the cabin air-conditioning & pressurization systems.

Electrical Power Generation

The power requirements of the OBIGGS systems may exceed the current available power.

For example, it can be seen from the chart below that the large transport airplanes will require between 115 and 145 KVA. A typical B747 Classic will produce a max continuous rate of 216 KVA of which 175 KVA is required in cruise leaving a maximum of 41 KVA. A further consideration is that this remaining power would be distributed between four power supply buses that cannot be permanently linked together.

A B747-400 can produce more power due to greater capacity generators but greater loads are required and the remaining power is again spread between power supply buses that cannot be permanently linked.

Depending on the airplane the increased power demands may require an increase to the capacity of the power generating system. The cost of increasing the electrical system capacity and the cost of maintaining a larger system were not calculated. Increasing system capacity would require larger generators, heavier wiring, and modifications to the electrical buss's to handle the loads. This may not even be an option on some airplanes due to engine limitations. Needless to say these changes would be expensive and time consuming.

Increased capacity power generating systems will increase unscheduled maintenance requirements. This additional unscheduled maintenance figure has not been quantified either.

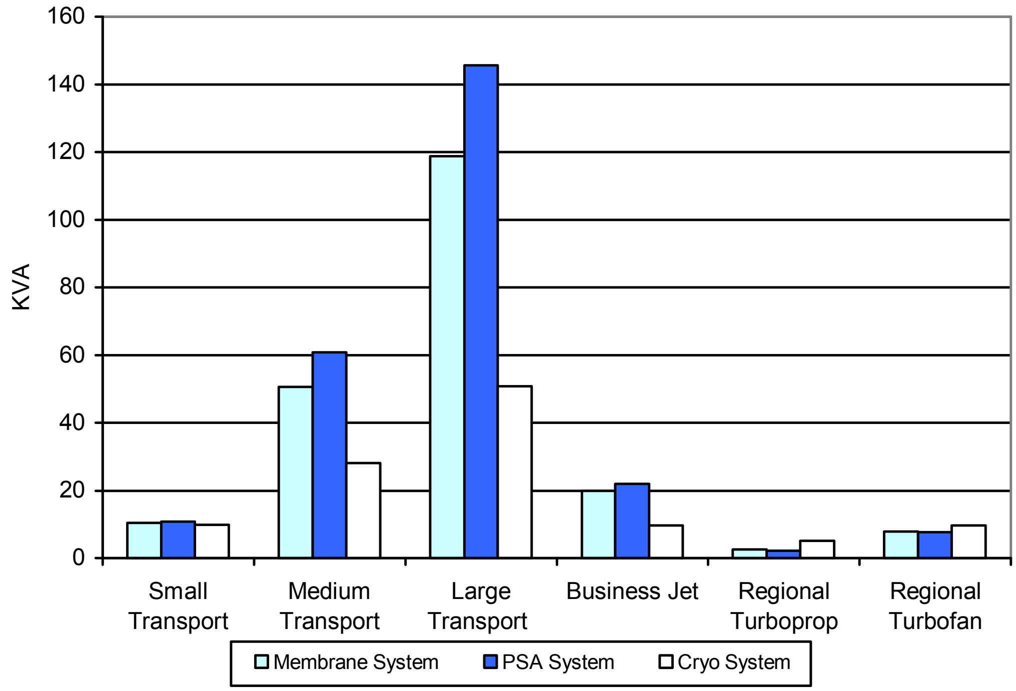


Figure 7-14. OBIGGS Power Requirements (kVA)

Airplane Pressurization System

As previously discussed in the scheduled maintenance section, extra man-hours have been added to the scheduled maintenance checks to perform a fuselage pressure decay check and accomplish repairs. Most operators' experience that has shown that airplanes, which are currently in service, periodically require this pressure decay check in order to maintain leakage limits prescribed in airplane maintenance manuals.

Because OBIGGS take air off the cabin, operators will have to reduce the allowable cabin air leakage rate to compensate for the demand and maintain a safety margin.

Should a leak occur during operation it may not allow the OBIGGS system, which uses some cabin air pressure, to be operated and instead of allowing the airplane to continue in service until the next scheduled pressure decay check immediate rectification will be required.

These extra-unscheduled maintenance costs have not been quantified.

Bleed Air System

Bleed air is also used by OBIGGS systems. Where this system interfaces with OBIGGS, utilization and associated scheduled & unscheduled maintenance will be increased. This increase in unscheduled maintenance has again not been quantified.

Stock Holding

The amount of spare components required to be held by an operator to ensure a reliable system varies according to system reliability, number of airplanes operated and the type of operation, ETOPS etc. It was not possible to make a detailed study of the costs for all systems and airplane types but from the figures already calculated it was possible to see that a pool of spares of $900,000 plus would be required to operate one airplane with a membrane system. This figure is a conservative estimate and does not take into account the storage, transportation, administration or capital investment costs or indeed any lease fees.

7.4 FLIGHT OPERATIONS

OBIGGS provides full time inerting protection in normal operations including descent, landing and post landing incidents that might present a tank ignition hazard. The system should be designed to be fully automatic and to be automatically shed in the case of engine power, electrical, bleed source or cabin pressure failures. It is assumed that it will be monitored by the flight management systems and annunciation of failure modes will be provided to the flight crew for recording in the maintenance log. Little if any cockpit instrumentation should be provided since inerting is considered to be a safety enhancement with MEL provisions and the crew is not expected to trouble shoot it to reactivate the system or discontinue routing operations. Some basic descriptions of the inerting concept and the OBIGGS equipment, location, power sources, heat exchangers, etc. need to be provided as additional training but should be limited to need to know. "If the crew cannot affect it, don't train for it." Both flight crew and dispatch personnel will be trained as far as MEL operating rules and the airplane may need to be re-routed to a suitable repair facility. The OBIGGS system will draw power, bleed air, and incur drag from intercooler openings and the increased fuel burn costs and will result in reduced range and endurance. Some long haul and international routes could be impacted.

7.5 GROUND OPERATIONS

The Onboard Gas Generating System after installation ideally would solve many of the ground base concerns and issues expressed earlier. It is the group’s opinion that a continual monitoring system be installed on the flight deck to insure proper inerting is taking place during the more critical phases of the airplane route structure such as taxi and takeoff. Any anomalies should immediately put on a master caution light to alert the flight crew. The flight crew would then have the ability to shut the system down if need be. Such as the APU fire warning system on many commercial airplanes, an aural warning system should be considered while the airplane is on the ground, in the event this system malfunctions without a flight crewmember on board.

A valid concern was raised with the possibility of nitrogen entering the cabin during continuous inerting with this system. Considerations should be given to redundancy with the material used to enhance safety for passengers and crewmembers. An example would be using double wall pipe for plumping purposes, and installing nitrogen sensors in the cabin.

Maintenance training procedures fall within the above mentioned training recommendations, and would merely be tailored again to the system desired for installation.

8.0 HYBRID ON-BOARD INERTING SYSTEMS

From an airplane operations and maintenance perspective there is very little difference between the full OBGI/OBIGG systems and the hybrid systems. The Airplane Operations & Maintenance Team looked at the hybrid systems but when it was determined that the system were nearly identical from this perspective, further work was discontinued. The reader may assume that the maintenance, operations and modifications impact described in the OBGIS and OBIGGS sections applies to the hybrid systems.

9.0 CONCLUSION

Although the fuel tank inerting system may enhance the safety of the airplanes fuel systems, there are several areas that still need to be addressed. The following are the concerns of this task group:

- The tasking statement does not clarify if inerting systems are classified as a safety system or fuel system enhancement. The assumption that inerting systems are not required for safety of flight and are designed and maintained as such is fundamental to the conclusions of this report.
- Any inerting system would introduce additional safety risks to flight crew, passengers, and maintenance personnel. Additional safety procedures would need to be put in place to mitigate these risks.

- If implemented, the requirement to retrofit inerting systems may place an unacceptable burden on the aircraft maintenance industry. Depending on the time scales there may not be sufficient facilities or personnel available to embody the modifications.
- The poor reliability of current on-board inerting system technology would restrict the introduction of fuel tank inerting systems on commercial aircraft. An improvement in reliability by an order of magnitude would be required to make them operationally viable.
- The implementation costs would be extremely high. Even if the inerting equipment was provided and installed for free, the cost to carry, maintenance and operational costs would exceed the benefits calculated in this document.

For all proposed inerting systems, additional maintenance labor hours will be required to maintain the system. This may require:

- The extension of the regular scheduled maintenance checks
- Additional maintenance checks
- Unscheduled unserviceability
- Contract maintenance assistance
- Additional hangar space

All of the above would lead to an increase in maintenance costs. Figures F3.3-1 through F3.3-6 in addendum F.B.1. compare the additional maintenance labor-hour estimates for each proposed system by airplane category.

REFERENCE

1. Occupational Safety & Health Administration (OSHA), *Accidents Database*. UK Health & Safety Executive, Safe Work in Confined Spaces.
2. Major Phillip Parker, *USAF School of Aerospace Medicine*, Potential Health Effects of Nitrogen Inerting of Commercial Airline Fuel Systems - Dec 2000

ADDENDUM F.A.1

MODIFICATION COST & LABOR-HOUR ESTIMATION

to

APPENDIX F

AIRPLANE OPERATION AND MAINTENANCE FINAL REPORT

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MODIFICATION COST & LABOR-HOUR ESTIMATION

GROUND BASED INERTING SYSTEM

LARGE AIRPLANE CATEGORY

Task	Number of Persons	Rate	Special Program		D/M - Check		Description
			Man Hours	Cost	Man Hours	Cost	
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Rotable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**1300**	$ 97,500	**1050**	$ 78,750	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane				$ 2,000,000		$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**1423**	**$ 2,129,230**	**1173**	**$ 110,480**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD GROUND INERTING SYSTEM

LARGE AIRPLANE CATEGORY - MEMBRANE

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2650**	$ 198,750	**2200**	$ 165,000	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane				$ 2,000,000		$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2773**	**$ 2,230,480**	**2323**	**$ 196,730**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD GROUND INERTING SYSTEM

LARGE AIRPLANE CATEGORY - PRESSURE SWING ADSORBTION

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2600**	$ 195,000	**2150**	$ 161,250	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane				$ 2,000,000		$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2723**	**$ 2,226,730**	**2273**	**$ 192,980**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD GROUND INERTING SYSTEM

LARGE AIRPLANE CATEGORY - CRYOGENIC

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2700**	$ 202,500	**2250**	$ 168,750	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane				$ 2,000,000		$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2823**	**$ 2,234,230**	**2373**	**$ 200,480**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD INERTING GAS GENERATING SYSTEM

LARGE AIRPLANE CATEGORY - MEMBRANE

Task	Number of Persons	Rate	Special Program		D/M - Check		Description
			Man Hours	Cost	Man Hours	Cost	
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2950**	$ 221,250	**2500**	$ 187,500	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane				$ 2,000,000		$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**3073**	**$ 2,252,980**	**2623**	**$ 219,230**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD INERTING GAS GENERATING SYSTEM

LARGE AIRPLANE CATEGORY - PRESSURE SWING ADSORPTION

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2900**	$ 217,500	**2450**	$ 183,750	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane				$ 2,000,000		$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**3023**	**$ 2,249,230**	**2573**	**$ 215,480**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD INERTING GAS GENERATING SYSTEM

LARGE AIRPLANE CATEGORY - CRYOGENIC

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**3000**	$ 225,000	**2550**	$ 191,250	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane				$ 2,000,000		$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**3123**	**$ 2,256,730**	**2673**	**$ 222,980**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

GROUND BASED INERTING SYSTEM

MEDIUM AIRPLANE CATEGORY

Task	Number of Persons	Rate	Special Program		D/M - Check		Description
			Man Hours	Cost	Man Hours	Cost	
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**1100**	$ 82,500	**1050**	$ 78,750	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**1223**	**$ 114,230**	**1173**	**$ 110,480**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD GROUND INERTING SYSTEM

MEDIUM AIRPLANE CATEGORY - MEMBRANE

Task	Number of Persons	Rate	Special Program		D/M - Check		Description
			Man Hours	Cost	Man Hours	Cost	
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2150**	$ 161,250	**1925**	$ 144,375	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane							Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2273**	**$ 192,980**	**2048**	**$ 176,105**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD GROUND INERTING SYSTEM

MEDIUM AIRPLANE CATEGORY - PRESSURE SWING ADSORBTION

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2100**	$ 157,500	**1875**	$ 140,625	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane							Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2223**	**$ 189,230**	**1998**	**$ 172,355**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD GROUND INERTING SYSTEM

CRYOGENIC AIRPLANE CATEGORY - CRYOGENIC

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2225**	$ 166,875	**2025**	$ 151,875	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane							Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2348**	**$ 198,605**	**2148**	**$ 183,605**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD INERTING GAS GENERATING SYSTEM

MEDIUM AIRPLANE CATEGORY - MEMBRANE

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2400**	$ 180,000	**2175**	$ 163,125	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2523**	**$ 211,730**	**2298**	**$ 194,855**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD INERTING GAS GENERATING SYSTEM

MEDIUM AIRPLANE CATEGORY - PRESSURE SWING ADSORPTION

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2350**	$ 176,250	**2125**	$ 159,375	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2473**	**$ 207,980**	**2248**	**$ 191,105**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD INERTING GAS GENERATING SYSTEM

MEDIUM AIRPLANE CATEGORY - CRYOGENIC

Task	Number of Persons	Rate	Special Program		D/M - Check		Description
			Man Hours	Cost	Man Hours	Cost	
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2475**	$ 185,625	**2275**	$ 170,625	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2598**	**$ 217,355**	**2398**	**$ 202,355**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

GROUND BASED INERTING SYSTEM

LARGE AIRPLANE CATEGORY

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**1200**	$ 90,000	**1050**	$ 78,750	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**1323**	**$ 121,730**	**1173**	**$ 110,480**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD GROUND INERTING SYSTEM

SMALL AIRPLANE CATEGORY - MEMBRANE

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2000**	$ 150,000	**1750**	$ 131,250	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane							Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2123**	**$ 181,730**	**1873**	**$ 162,980**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD GROUND INERTING SYSTEM

SMALL AIRPLANE CATEGORY - PRESSURE SWING ADSORBTION

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**1950**	$ 146,250	**1700**	$ 127,500	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane							Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2073**	**$ 177,980**	**1823**	**$ 159,230**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD GROUND INERTING SYSTEM

SMALL AIRPLANE CATEGORY - CRYOGENIC

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2050**	$ 153,750	**1850**	$ 138,750	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane							Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2173**	**$ 185,480**	**1973**	**$ 170,480**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD INERTING GAS GENERATING SYSTEM

SMALL AIRPLANE CATEGORY - MEMBRANE

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2200**	$ 165,000	**1950**	$ 146,250	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
	16			$ -		$ -	Number of mechanics that follows the class.
Flight Operations Engineering:							Reviews the Engineering Project creates new W&B sheets and performance penalties
Total Recurring	**28**		**2315**	**$ 182,650**	**2065**	**$ 163,900**	**Per airplane**
Reason of revision:						Estimated by:	Modification & Retrofit Sub Team

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD INERTING GAS GENERATING SYSTEM

SMALL AIRPLANE CATEGORY - PRESSURE SWING ADSORPTION

Task	Number of Persons	Rate	Special Program		D/M - Check		Description
			Man Hours	Cost	Man Hours	Cost	
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2150**	$ 161,250	**1900**	$ 142,500	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2273**	**$ 192,980**	**2023**	**$ 174,230**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

ON-BOARD INERTING GAS GENERATING SYSTEM

SMALL AIRPLANE CATEGORY - CRYOGENIC

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**2250**	$ 168,750	**2050**	$ 153,750	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**2373**	**$ 200,480**	**2173**	**$ 185,480**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

GROUND BASED INERTING SYSTEM

REGIONAL TURBOFAN AIRPLANE CATEGORY

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**1100**	$ 82,500	**900**	$ 67,500	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**1223**	**$ 114,230**	**1023**	**$ 99,230**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

GROUND BASED INERTING SYSTEM

REGIONAL TURBOFAN AIRPLANE CATEGORY (WITH BLADDER TANKS)

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**1750**	$ 131,250	**1550**	$ 116,250	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**1873**	**$ 162,980**	**1673**	**$ 147,980**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

GROUND BASED INERTING SYSTEM

REGIONAL TURBOPROP AIRPLANE CATEGORY

Task	Number of Persons	Rate	Special Program		D/M - Check		Description
			Man Hours	Cost	Man Hours	Cost	
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75		$ -		$ -	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**123**	**$ 31,730**	**123**	**$ 31,730**	**Per airplane**

MODIFICATION COST & LABOR-HOUR ESTIMATION

GROUND BASED INERTING SYSTEM

BUSSINESS JET AIRPLANE CATEGORY

Task	Number of Persons	Rate	Special Program Man Hours	Special Program Cost	D/M - Check Man Hours	D/M - Check Cost	Description
NON-RECURRING							
Engineering							
Service Bulletin review	1	$ 110	**30**	$ 3,300	**30**	$ 3,300	Evaluating Service Bulletin
Engineering Data	1	$ 50	**35**	$ 1,750	**35**	$ 1,750	Enters the work card requirements into the data base.
Engineering Drafting	1	$ 110	**25**	$ 2,750	**25**	$ 2,750	Creates the necessary drawings and figures necessary for the project.
Inventory Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering BOM and does all material provisions and allocations
Planning	1	$ 110	**20**	$ 2,200	**20**	$ 2,200	Reviews the Engineering Project and provides information for accomplishment.
Maintenance Programs	1	$ 110	**35**	$ 3,850	**35**	$ 3,850	Reviews the Engineering Project for effect on other projects, tasks and jobcards.
Records	1	$ 50	**10**	$ 500	**10**	$ 500	Creates the necessary Project tracking numbers and maintains the records.
Quality Assurance	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Reviews the Engineering Project for Regulatory compliance.
Reliability	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Tracks and maintains the records for all the components and their trends. FAR requirement.
Tech Publications							
Manuals: AMM	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Aircraft Maintenance Manual
IPC	1	$ 50	**20**	$ 1,000	**20**	$ 1,000	Illustrated Parts List
CMM	1	$ 50	**10**	$ 500	**10**	$ 500	Component Maintenance Manual
AFM	1	$ 50	**10**	$ 500	**10**	$ 500	Aircraft Flight Manual
FOM	1	$ 50	**10**	$ 500	**10**	$ 500	Flight Operations Manual
SRM	1	$ 50	**10**	$ 500	**10**	$ 500	Structural Repair Manual
FUELLING	1	$ 50	**15**	$ 750	**15**	$ 750	Fuelling Manual
RMM	1	$ 50	**10**	$ 500	**10**	$ 500	Ramp Manual
GMM	1	$ 50	**40**	$ 2,000	**40**	$ 2,000	General Maintenance Manual that includes Company's Procedures
WDM	2	$ 50	**150**	$ 7,500	**150**	$ 7,500	Wire Diagram Manual
Training Documentation	1	$ 75	**15**	$ 1,125	**15**	$ 1,125	Making of necessary training documentation
Training Material				$ 1,000		$ 1,000	Material
Material Control							
Routable parts	1	$ 50	**43**	$ 2,125	**43**	$ 2,125	Make known the Routable into the company systems
Consumable parts	1	$ 50	**25**	$ 1,250	**25**	$ 1,250	Make known the Consumables into the company systems
Spares estimation	1	$ 50	**8**	$ 400	**8**	$ 400	The amount of spares depending on the MTBUR
Tooling	1	$ 50	**30**	$ 1,500	**30**	$ 1,500	Make known the Tooling into the company systems
RECURRING							
Project's Estimated Time							
Accomplishment	10	$ 75	**500**	$ 37,500		$ -	See Addendum F.A.2 for detailed tasks
Engineering support	1	$ 110	**100**	$ 11,000	**100**	$ 11,000	Support to hangar during modification
Kit costs							Kit costs is not included. Design Team didn't provided the data.
Kit Storage costs							No kit data available
Extra down time airplane						$ -	Extra time airplane is on ground due to this modification. Including lost of revenue & hangar space.
Training							This is the cost for 1 training class only. A correct estimation was not feasible.
Instructors	1	$ 110	**15**	$ 1,650	**15**	$ 1,650	Giving class + preparation time
Training Classroom				$ 5,000		$ 5,000	Average rent cost for classroom
Training Mechanics	16	$ 110	**8**	$ 14,080	**8**	$ 14,080	Number of mechanics that follows the class.
Total NON-Recurring	**25**		**641**	**$ 41,200**	**641**	**$ 41,200**	**Per airplane type/ per operator**
Total Recurring	**28**		**623**	**$ 69,230**	**123**	**$ 31,730**	**Per airplane**

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ADDENDUM F.A.2

MODIFICATION PROJECT LABOR-HOUR ESTIMATION

to

APPENDIX F

AIRPLANE OPERATION AND MAINTENANCE

FINAL REPORT

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Airplane type: LARGE *(Boeing 747)*	Description: **Ground Based Inerting Systems**	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	43	0
Mech.	Defuel and drain CW tank	4	0
Mech.	Open, ventilate and close after modification CW tank	29	0
Avio.	Open/close aft side of MEC	3	0
Mech.	Remove/reinstall RH seats, carpet, floorpanels above RH cable raceway sta 1000-1265	29	0
Avio.	Remove/reinstall floorprox,seat to seat cables and raceways RH sta 1000-1265	14	0
Mech.	Remove/reinstall ceiling panels in fwd cargo compt. for access to cable raceways	7	0
Mech.	Remove/install in A zone LH seats and side wall panels	7	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	43	0
Mech.	Clean various locations before modification	44	43
Avio.	Install wiring between flight deck,MEC and new components located in airco. compt. 4	179	179
Sht.mtl.	Install feed through structural provisions in CW tank aft skin at sta 1260	179	179
Sht.mtl.	Install provisions for distribution manifold in CW tank	57	57
Mech.	Install distribution manifold in CW tank	100	100
Sht.mtl.	Install provisions for thermal relief valve and isolation valve installation	14	14
Mech.	Install thermal relief valve and isolation valve	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	57	57
Sht.mtl.	Inst. provisions for double wall pipe,witness drain etc. from fill panel to CW tank sta 1260	14	14
Mech.	Inst. double wall pipe,witness drain etc. from fill panel to CW tank sta 1260	21	21
Mech/Avio	Test ground based distribution system (3x)	29	29
Mech/Avio	Test several systems due to partial flight deck dismantling	100	100
	Total labor-hours per aircraft	**980**	**800**
Mech/Avio	Inspection mechanics/avionics	132	96
Sht.mtl.	Install heat exchanger on header assy	32	32
	Round off/unforeseen work	157	122
	Total labor-hours including inspection	**1300**	**1050**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: LARGE *(Boeing 747)*	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** MEMBRANE	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	71	0
Mech.	Defuel and drain all fuel tanks	14	0
Mech.	Open, ventilate and close after modification all fuel tanks	93	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	100	100
Mech.	Remove/install several wing to body fairing panels R.H.	43	0
Mech.	Remove/install several sidewall and ceiling panels in fwd. cargo compt.R.H.	29	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in main cabin at sta.1000 R.H.	21	0
Avio.	Remove/install floor prox etc in main cabin at sta.1000 R.H.	7	0
Avio.	Open/close aft side of MEC	3	0
Mech.	Remove/install in A zone LH seats and side wall panels	7	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	43	0
Mech.	Clean various locations before and after modification	74	69
Avio.	Install wiring between flight deck,MEC and new components located in airco. compt. 4	286	286
Sht.mtl.	Install provisions for filter installation in fwd. cargo compt. approx. at sta.980 RH	36	36
Mech.	Install filter assy and element	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	64	64
Mech.	Install shut off valve and filter to shut off valve ducting	7	7
Sht.mtl.	Install provision for compressor installation in airco compt. 4	36	36
Mech.	Install compressor and shut off valve to compressor ducting	10	10
Sht.mtl.	Install provisions for bleed air items	29	29
Sht.mtl.	Total labor-hours per aircraft	57	57
Mech.	Inspection mechanics/avionics	29	29
Mech.	Install heat exchanger on header assy	7	7
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	71	71
Mech.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Sht.mtl.	Install provisions for electrically driven cooling fan installation	10	10
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for water seperator/filter, low flow ASM and high flow ASM installation	131	131
Mech.	Install water seperator/filter, low flow ASM and high flow ASM systems	29	29
Avio.	Install water seperator/filter, low flow ASM and high flow ASM systems	29	29
Mech.	Install ducting from heat exch.to water seperator/filter, low flow/high flow ASM systems	21	21
Mech.	Install HX bypass valve and ducting	5	5
Sht.mtl.	Install provisions for high flow valve and relief valve installation	21	21
Mech.	Install high flow valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in CW tank at sta. 1000	179	179
Sht.mtl.	Install feed through and shut off valve provisions in fuselage skin (airco compt 4 to cabin)	64	64
Mech.	Install ducting from relief valve to CW tank sta.1000	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 7 fuel tanks	143	143
Mech.	Install NEA gas distribution system in all 7 fuel tanks	286	286
Mech/Avio	Test cryogenic distillation system (3x)	50	50
Mech/Avio	Test several systems due to partial flight deck dismantling	100	100
	Total labor-hours per aircraft	**2290**	**1940**
Mech/Avio	Inspection mechanics/avionics	290	220
Sht.mtl.	Inspection sheetmetal	84	84
	Round off/unforeseen work	286	256
	Total labor-hours including inspection	**2950**	**2500**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: LARGE *(Boeing 747)*	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** PRESSURE SWING ABSORBTION	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	71	0
Mech.	Defuel and drain all fuel tanks	14	0
Mech.	Open, ventilate and close after modification all fuel tanks	93	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	100	100
Mech.	Remove/install several wing to body fairing panels R.H.	43	0
Mech.	Remove/install several sidewall and ceiling panels in fwd. cargo compt.R.H.	29	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in main cabin at sta.1000 R.H.	21	0
Avio.	Remove/install floor prox etc in main cabin at sta.1000 R.H.	7	0
Avio.	Open/close aft side of MEC	3	0
Mech.	Remove/install in A zone LH seats and side wall panels	7	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	43	0
Mech.	Clean various locations before and after modification	74	74
Avio.	Install wiring between flight deck,MEC and new components located in airco. compt. 4	286	286
Sht.mtl.	Install provisions for filter installation in fwd. cargo compt. approx. at sta.980 RH	36	36
Mech.	Install filter assy and element	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	64	64
Mech.	Install shut off valve and filter to shut off valve ducting	7	7
Sht.mtl.	Install provision for compressor installation in airco compt. 4	36	36
Mech.	Install compressor and shut off valve to compressor ducting	10	10
Sht.mtl.	Install provisions for bleed air items	29	29
Sht.mtl.	Total labor-hours per aircraft	57	57
Mech.	Inspection mechanics/avionics	29	29
Mech.	Install heat exchanger on header assy	7	7
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	71	71
Mech.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Sht.mtl.	Install provisions for electrically driven cooling fan installation	10	10
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for water seperator/filter and ASM installation	100	100
Mech.	Install water seperator/filter and ASM systems	21	21
Avio.	Install water seperator/filter and ASM systems	21	21
Mech.	Install ducting from heat exch.to water seperator/filter, low flow/high flow ASM systems	21	21
Mech.	Install HX bypass valve and ducting	5	5
Sht.mtl.	Install provisions for high flow valve and relief valve installation	21	21
Mech.	Install high flow valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in CW tank at sta. 1000	179	179
Sht.mtl.	Install feed through and shut off valve provisions in fuselage skin (airco compt 4 to cabin)	64	64
Mech.	Install ducting from relief valve to CW tank sta.1000	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 7 fuel tanks	143	143
Mech.	Install NEA gas distribution system in all 7 fuel tanks	286	286
Mech/Avio	Test cryogenic distillation system (3x)	50	50
Mech/Avio	Test several systems due to partial flight deck dismantling	100	100
	Total labor-hours per aircraft	**2245**	**1900**
Mech/Avio	Inspection mechanics/avionics	287	218
Sht.mtl.	Inspection sheetmetal	81	81
	Round off/unforeseen work	287	251
	Total labor-hours including inspection	**2900**	**2450**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: LARGE *(Boeing 747)*	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** CRYOGENIC	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	71	0
Mech.	Defuel and drain all fuel tanks	14	0
Mech.	Open, ventilate and close after modification all fuel tanks	93	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	100	100
Mech.	Remove/install several wing to body fairing panels R.H.	43	0
Mech.	Remove/install several sidewall and ceiling panels in fwd. cargo compt.R.H.	29	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in main cabin at sta.1000 R.H.	21	0
Avio.	Remove/install floor prox etc in main cabin at sta.1000 R.H.	7	0
Avio.	Open/close aft side of MEC	3	0
Mech.	Remove/install in A zone LH seats and side wall panels	7	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	43	0
Mech.	Clean various locations before and after modification	74	74
Avio.	Install wiring between flight deck,MEC and new components located in airco. compt. 4	286	286
Sht.mtl.	Install provisions for filter installation in fwd. cargo compt. approx. at sta.980 RH	36	36
Mech.	Install filter assy and element	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	64	64
Mech.	Install shut off valve and filter to shut off valve ducting	7	7
Sht.mtl.	Install provision for compressor installation in airco compt. 4	36	36
Mech.	Install compressor and shut off valve to compressor ducting	10	10
Sht.mtl.	Install provisions for bleed air items	29	29
Sht.mtl.	Total labor-hours per aircraft	57	57
Mech.	Inspection mechanics/avionics	29	29
Mech.	Install heat exchanger on header assy	7	7
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	71	71
Mech.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Sht.mtl.	Install provisions for electrically driven cooling fan installation	10	10
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for storage syst.,cryogenic refrigerator and distillation syst.installation	171	171
Mech.	Install storage,cryogenic refrigerator and distillation systems	36	36
Avio.	Install storage,cryogenic refrigerator and distillation systems	36	36
Mech.	Install ducting from heat exchanger to refrigerator,distillation and storage systems	21	21
Mech.	Install HX bypass valve and ducting	5	5
Sht.mtl.	Install provisions for modulating valve and relief valve installation	21	21
Mech.	Install modulating valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in CW tank at sta. 1000	179	179
Sht.mtl.	Install feed through and shut off valve provisions in fuselage skin (airco compt 4 to cabin)	64	64
Mech.	Install ducting from relief valve to CW tank sta.1000	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 7 fuel tanks	143	143
Mech.	Install NEA gas distribution system in all 7 fuel tanks	286	286
Mech/Avio	Test cryogenic distillation system (3x)	50	50
Mech/Avio	Test several systems due to partial flight deck dismantling	100	100
	Total labor-hours per aircraft	**2345**	**2000**
Mech/Avio	Inspection mechanics/avionics	293	224
Sht.mtl.	Inspection sheetmetal	88	88
	Round off/unforeseen work	274	238
	Total labor-hours including inspection	**3000**	**2550**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: MEDIUM *(Boeing 767)*	Description: **Ground Based Inerting Systems**	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	<u>Accomplishment:</u>		
Mech.	Dock and undock airplane and raise and lower airplane	14	0
Mech.	Defuel and drain CW tank	3	0
Mech.	Open, ventilate and close after modification CW tank	21	0
Avio.	Open/close aft side of E/E	3	0
Mech.	Remove/reinstall RH seats, carpet, floorpanels above RH cable raceway sta 933	29	0
Avio.	Remove/reinstall floorprox,seat to seat cables and raceways RH sta 933	14	0
Mech.	Remove/reinstall ceiling panels in aft cargo compt. for access to cable raceways	7	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	43	0
Mech.	Clean various locations before modification	44	43
Avio.	Install wiring between flight deck, E/E and new components located in tail cone	179	157
Sht.mtl.	Install feed through structural provisions in CW tank aft skin at sta 955	179	157
Sht.mtl.	Install provisions for distribution manifold in CW tank	57	57
Mech.	Install distribution manifold in CW tank	100	100
Sht.mtl.	Install provisions for thermal relief valve and isolation valve installation	14	14
Mech.	Install thermal relief valve and isolation valve	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	57	57
Sht.mtl.	Inst. provisions for double wall pipe,witness drain etc. from fill panel to CW tank sta 955	14	14
Mech.	Inst. double wall pipe,witness drain etc. from fill panel to CW tank sta 955	21	21
Mech/Avio	Test ground based distribution system (3x)	29	29
Mech/Avio	Test several systems due to partial flight deck dismantling	100	100
	Total manhours per aircraft	**935**	**757**
Mech/Avio	Inspection mechanics/avionics	123	56
Sht.mtl.	Inspection sheetmetal	32	48
	Round off/unforeseen work	110	89
	Total manhours including inspection	**1200**	**950**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: MEDIUM *(Boeing 767)*	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** MEMBRANE	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	29	0
Mech.	Defuel and drain all fuel tanks	14	0
Mech.	Open, ventilate and close after modification all fuel tanks	43	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	43	43
Mech.	Remove/install several sidewall and ceiling panels in fwd. cargo compt.R.H.	29	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in main cabin at sta.933 R.H.	21	0
Avio.	Remove/install floor prox etc in main cabin at sta.933 R.H.	7	0
Avio.	Open/close aft side of E/E	3	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	29	0
Mech.	Clean various locations before and after modification	57	57
Avio.	Install wiring between flight deck, E/E and new components located in tail cone	257	257
Sht.mtl.	Install provisions for filter installation in bulk cargo compt. approx. at sta.1540 RH	36	36
Mech.	Install filter assy and element	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	64	64
Mech.	Install shut off valve and filter to shut off valve ducting	7	7
Sht.mtl.	Install provision for compressor installation in tail cone	36	36
Mech.	Install compressor and shut off valve to compressor ducting	10	10
Sht.mtl.	Install provisions for bleed air items	29	29
Sht.mtl.	Install provisions for header/ heat exchanger installation in tail cone	57	57
Mech.	Install header assy, bleed air items and compressor to header assy ducting	29	29
Mech.	Install heat exchanger on header assy	7	7
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	71	71
Mech.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Sht.mtl.	Install provisions for electrically driven cooling fan installation	10	10
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for storage syst.,cryogenic refrigerator and distillation syst.installation	129	131
Mech.	Install storage,cryogenic refrigerator and distillation systems	29	29
Avio.	Install storage,cryogenic refrigerator and distillation systems	29	29
Mech.	Install ducting from heat exchanger to refrigerator,distillation and storage systems	21	21
Mech.	Install HX bypass valve and ducting	5	5
Sht.mtl.	Install provisions for modulating valve and relief valve installation	21	21
Mech.	Install modulating valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in CW tank at sta. 955	143	179
Sht.mtl.	Install feed through and shut off valve provisions in fuselage skin (tail cone to cabin)	64	64
Mech.	Install ducting from relief valve to CW tank sta.955	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 3 fuel tanks	107	107
Mech.	Install NEA gas distribution system in all 3 fuel tanks	214	214
Mech/Avio	Test cryogenic distillation system (3x)	50	50
Mech/Avio	Test several systems due to partial flight deck dismantling	71	71
	Total manhours per aircraft	**1857**	**1706**
Mech/Avio	Inspection mechanics/avionics	218	180
Sht.mtl.	Inspection sheetmetal	77	81
	Round off/unforeseen work	248	233
	Total manhours including inspection	**2400**	**2200**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: MEDIUM *(Boeing 767)*	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** PRESSURE SWING ABSORBTION	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	29	0
Mech.	Defuel and drain all fuel tanks	14	0
Mech.	Open, ventilate and close after modification all fuel tanks	43	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	43	43
Mech.	Remove/install several sidewall and ceiling panels in fwd. cargo compt.R.H.	29	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in main cabin at sta.933 R.H.	21	0
Avio.	Remove/install floor prox etc in main cabin at sta.933 R.H.	7	0
Avio.	Open/close aft side of E/E	3	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	29	0
Mech.	Clean various locations before and after modification	57	64
Avio.	Install wiring between flight deck, E/E and new components located in tail cone	257	257
Sht.mtl.	Install provisions for filter installation in bulk cargo compt. approx. at sta.1540 RH	36	36
Mech.	Install filter assy and element	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	64	64
Mech.	Install shut off valve and filter to shut off valve ducting	7	7
Sht.mtl.	Install provision for compressor installation in tail cone	36	36
Mech.	Install compressor and shut off valve to compressor ducting	10	10
Sht.mtl.	Install provisions for bleed air items	29	29
Sht.mtl.	Install provisions for header/ heat exchanger installation in tail cone	57	57
Mech.	Install header assy, bleed air items and compressor to header assy ducting	29	29
Mech.	Install heat exchanger on header assy	7	7
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	71	71
Mech.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Sht.mtl.	Install provisions for electrically driven cooling fan installation	10	10
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for storage syst.,cryogenic refrigerator and distillation syst.installation	100	100
Mech.	Install storage,cryogenic refrigerator and distillation systems	21	21
Avio.	Install storage,cryogenic refrigerator and distillation systems	21	21
Mech.	Install ducting from heat exchanger to refrigerator,distillation and storage systems	21	21
Mech.	Install HX bypass valve and ducting	5	5
Sht.mtl.	Install provisions for modulating valve and relief valve installation	21	21
Mech.	Install modulating valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in CW tank at sta. 955	143	179
Sht.mtl.	Install feed through and shut off valve provisions in fuselage skin (tail cone to cabin)	64	64
Mech.	Install ducting from relief valve to CW tank sta.955	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 3 fuel tanks	107	107
Mech.	Install NEA gas distribution system in all 3 fuel tanks	214	214
Mech/Avio	Test cryogenic distillation system (3x)	50	50
Mech/Avio	Test several systems due to partial flight deck dismantling	71	71
	Total manhours per aircraft	**1814**	**1668**
Mech/Avio	Inspection mechanics/avionics	215	179
Sht.mtl.	Inspection sheetmetal	74	77
	Round off/unforeseen work	247	225
	Total manhours including inspection	**2350**	**2150**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: MEDIUM (Boeing 767)	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** CRYOGENIC	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	29	0
Mech.	Defuel and drain all fuel tanks	14	0
Mech.	Open, ventilate and close after modification all fuel tanks	43	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	43	43
Mech.	Remove/install several sidewall and ceiling panels in fwd. cargo compt.R.H.	29	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in main cabin at sta.933 R.H.	21	0
Avio.	Remove/install floor prox etc in main cabin at sta.933 R.H.	7	0
Avio.	Open/close aft side of E/E	3	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	29	0
Mech.	Clean various locations before and after modification	57	74
Avio.	Install wiring between flight deck, E/E and new components located in tail cone	257	257
Sht.mtl.	Install provisions for filter installation in bulk cargo compt. approx. at sta.1540 RH	36	36
Mech.	Install filter assy and element	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	64	64
Mech.	Install shut off valve and filter to shut off valve ducting	7	7
Sht.mtl.	Install provision for compressor installation in tail cone	36	36
Mech.	Install compressor and shut off valve to compressor ducting	10	10
Sht.mtl.	Install provisions for bleed air items	29	29
Sht.mtl.	Install provisions for header/ heat exchanger installation in tail cone	57	57
Mech.	Install header assy, bleed air items and compressor to header assy ducting	29	29
Mech.	Install heat exchanger on header assy	7	7
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	71	71
Mech.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Sht.mtl.	Install provisions for electrically driven cooling fan installation	10	10
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for storage syst.,cryogenic refrigerator and distillation syst.installation	171	171
Mech.	Install storage,cryogenic refrigerator and distillation systems	36	36
Avio.	Install storage,cryogenic refrigerator and distillation systems	36	36
Mech.	Install ducting from heat exchanger to refrigerator,distillation and storage systems	21	21
Mech.	Install HX bypass valve and ducting	5	5
Sht.mtl.	Install provisions for modulating valve and relief valve installation	21	21
Mech.	Install modulating valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in CW tank at sta. 955	143	179
Sht.mtl.	Install feed through and shut off valve provisions in fuselage skin (tail cone to cabin)	64	64
Mech.	Install ducting from relief valve to CW tank sta.955	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 3 fuel tanks	107	107
Mech.	Install NEA gas distribution system in all 3 fuel tanks	214	214
Mech/Avio	Test cryogenic distillation system (3x)	50	50
Mech/Avio	Test several systems due to partial flight deck dismantling	71	71
	Total manhours per aircraft	**1914**	**1778**
Mech/Avio	Inspection mechanics/avionics	221	186
Sht.mtl.	Inspection sheetmetal	81	85
	Round off/unforeseen work	234	251
	Total manhours including inspection	**2450**	**2300**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: MEDIUM (MD11)	Description: **Ground Based Inerting Systems**	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	14	0
Mech.	Defuel, drain and vent aux tank	14	0
Mech.	Open and close after modification aux tank	7	0
Avio.	Open/close aft side of avionics compartment	3	0
Mech.	Remove/reinstall RH seats, carpet, floorpanels	14	0
Avio.	Remove/reinstall floorprox,seat to seat cables and raceways RH sta 1000-1265	0	0
Mech.	Remove/reinstall ceiling panels in fwd cargo compt. for access to cable raceways	7	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	29	0
Mech.	Clean various locations before modification	36	36
Avio.	Install wiring between flight deck, avio comp and new components located in zone 114	114	114
Sht.mtl.	Install feed through structural provisions in aux tank	143	143
Sht.mtl.	Install provisions for distribution manifold in aux tank	50	50
Mech.	Install distribution manifold in aux tank	86	86
Sht.mtl.	Install provisions for thermal relief valve and isolation valve installation	14	14
Mech.	Install thermal relief valve and isolation valve	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	57	57
Sht.mtl.	Inst. provisions for double wall pipe,witness drain etc. from fill panel to aux tank	21	21
Mech.	Inst. double wall pipe,witness drain etc. from fill panel to aux tank	29	29
Mech/Avio	Test ground based distribution system (3x)	29	29
Mech/Avio	Test several systems due to partial flight deck dismantling	71	71
	Total manhours per aircraft	**746**	**657**
Mech/Avio	Inspection mechanics/avionics	92	96
Sht.mtl.	Inspection sheetmetal	29	32
	Round off/unforeseen work	133	122
	Total manhours including inspection	**1000**	**1050**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: MEDIUM *(MD11)*	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** MEMBRANE	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	29	0
Mech.	Defuel, drain, purge and vent all fuel tanks	33	0
Mech.	Open and close after modification all fuel tanks	43	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	100	100
Mech.	Remove/install several sidewall and ceiling panels in fwd. cargo compt.R.H.	14	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in cabin	14	0
Avio.	Open/close aft side of avionics compartment	3	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	29	0
Mech.	Clean various locations before and after modification	57	54
Avio.	Install wiring between flight deck, avio comp and new components located in zone 114	214	214
Sht.mtl.	Install provisions for filter installation in fwd. cargo compartment	29	29
Mech.	Install filter assy and element	3	3
Sht.mtl.	Modify lwr. panel for fill adaptor/components	43	43
Mech.	Install shut off valve and filter to shut off valve ducting	6	6
Sht.mtl.	Install provision for compressor installation in zone 114	29	29
Mech.	Install compressor and shut off valve to compressor ducting	9	9
Sht.mtl.	Install provisions for bleed air items	21	21
Sht.mtl.	Install provisions for header/ heat exchanger installation in zone 114	43	43
Mech.	Install header assy, bleed air items and compressor to header assy ducting	29	29
Mech.	Install heat exchanger on header assy	6	6
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	75	75
Mech.	Make split in ram air duct	7	7
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	20	20
Sht.mtl.	Install provisions for electrically driven cooling fan installation	25	25
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for water seperator/filter, low flow ASM and high flow ASM installation	129	129
Mech.	Install water seperator/filter, low flow ASM and high flow ASM systems	29	29
Avio.	Install water seperator/filter, low flow ASM and high flow ASM systems	29	29
Mech.	Install ducting from heat exch.to water seperator/filter, low flow/high flow ASM systems	14	14
Mech.	Install HX bypass valve and ducting	4	4
Sht.mtl.	Install provisions for high flow valve and relief valve installation	21	21
Mech.	Install high flow valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in upper aux tank	143	143
Sht.mtl.	Install feed through and relief valve provisions in fuselage skin (zone 114 to cabin)	71	71
Mech.	Install ducting from relief valve to upper aux tank	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 5 fuel tanks (tail tank not included)	129	129
Mech.	Install NEA gas distribution system in all 5 fuel tanks	257	257
Mech/Avio	Test cryogenic distillation system (3x)	43	43
Mech/Avio	Test several systems due to partial flight deck dismantling	71	71
	Total manhours per aircraft	**1869**	**1688**
Mech/Avio	Inspection mechanics/avionics	222	186
Sht.mtl.	Inspection sheetmetal	76	76
	Round off/unforeseen work	233	201
	Total manhours including inspection	**2400**	**2150**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: MEDIUM *(MD11)*	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** PRESSURE SWING ABSORBTION	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	29	0
Mech.	Defuel, drain, purge and vent all fuel tanks	33	0
Mech.	Open and close after modification all fuel tanks	43	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	100	100
Mech.	Remove/install several sidewall and ceiling panels in fwd. cargo compt.R.H.	14	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in cabin	14	0
Avio.	Open/close aft side of avionics compartment	3	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	29	0
Mech.	Clean various locations before and after modification	57	57
Avio.	Install wiring between flight deck, avio comp and new components located in zone 114	214	214
Sht.mtl.	Install provisions for filter installation in fwd. cargo compartment	29	29
Mech.	Install filter assy and element	3	3
Sht.mtl.	Modify lwr. panel for fill adaptor/components	43	43
Mech.	Install shut off valve and filter to shut off valve ducting	6	6
Sht.mtl.	Install provision for compressor installation in zone 114	29	29
Mech.	Install compressor and shut off valve to compressor ducting	9	9
Sht.mtl.	Install provisions for bleed air items	21	21
Sht.mtl.	Install provisions for header/ heat exchanger installation in zone 114	43	43
Mech.	Install header assy, bleed air items and compressor to header assy ducting	29	29
Mech.	Install heat exchanger on header assy	6	6
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	75	75
Mech.	Make split in ram air duct	7	7
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	20	20
Sht.mtl.	Install provisions for electrically driven cooling fan installation	25	25
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for water seperator/filter and ASM installation	100	100
Mech.	Install water seperator/filter and ASM systems	21	21
Avio.	Install water seperator/filter and ASM systems	21	21
Mech.	Install ducting from heat exch.to water seperator/filter, low flow/high flow ASM systems	14	14
Mech.	Install HX bypass valve and ducting	4	4
Sht.mtl.	Install provisions for high flow valve and relief valve installation	21	21
Mech.	Install high flow valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in upper aux tank	143	143
Sht.mtl.	Install feed through and relief valve provisions in fuselage skin (zone 114 to cabin)	71	71
Mech.	Install ducting from relief valve to upper aux tank	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 5 fuel tanks (tail tank not included)	129	129
Mech.	Install NEA gas distribution system in all 5 fuel tanks	257	257
Mech/Avio	Test cryogenic distillation system (3x)	43	43
Mech/Avio	Test several systems due to partial flight deck dismantling	71	71
	Total manhours per aircraft	**1826**	**1648**
Mech/Avio	Inspection mechanics/avionics	219	184
Sht.mtl.	Inspection sheetmetal	73	73
	Round off/unforeseen work	231	196
	Total manhours including inspection	**2350**	**2100**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: MEDIUM (MD11)	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** CRYOGENIC	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	29	0
Mech.	Defuel, drain purge and vent all fuel tanks	33	0
Mech.	Open and close after modification all fuel tanks	43	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	100	100
Mech.	Remove/install several sidewall and ceiling panels in fwd. cargo compt.R.H.	14	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in cabin	14	0
Avio.	Remove/install floor prox etc in main cabin at sta.1000 R.H.	0	0
Avio.	Open/close aft side of avionics compartment	3	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	29	0
Mech.	Clean various locations before and after modification	57	57
Avio.	Install wiring between flightdeck, avionics comp and new components located in zone 114.	214	214
Sht.mtl.	Install provisions for filter installation in fwd. cargo compartment.	29	29
Mech.	Install filter assy and element	3	3
Sht.mtl.	Modify lwr. panel for fill adaptor/components	43	43
Mech.	Install shut off valve and filter to shut off valve ducting	6	6
Sht.mtl.	Install provision for compressor installation in zone 114	29	29
Mech.	Install compressor and shut off valve to compressor ducting	9	9
Sht.mtl.	Install provisions for bleed air items	21	21
Sht.mtl.	Install provisions for header/ heat exchanger installation in zone 114	43	43
Mech.	Install header assy, bleed air items and compressor to header assy ducting	29	29
Mech.	Install heat exchanger on header assy	6	6
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	75	75
Mech.	Make split in ram air duct	7	7
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	25	25
Sht.mtl.	Install provisions for electrically driven cooling fan installation	9	9
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for storage syst.,cryogenic refrigerator and distillation syst.installation	171	171
Mech.	Install storage,cryogenic refrigerator and distillation systems	43	43
Avio.	Install storage,cryogenic refrigerator and distillation systems	36	36
Mech.	Install ducting from heat exchanger to refrigerator,distillation and storage systems	17	17
Mech.	Install HX bypass valve and ducting	4	4
Sht.mtl.	Install provisions for modulating valve and relief valve installation	21	21
Mech.	Install modulating valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in upper aux tank	143	143
Sht.mtl.	Install feed through and relief valve provisions in fuselage skin (zone 114 to cabin)	71	71
Mech.	Install ducting from relief valve to upper aux tank	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 5 fuel tanks (tail tank not included)	129	129
Mech.	Install NEA gas distribution system in 5 fuel tanks	257	257
Mech/Avio	Test cryogenic distillation system (3x)	43	43
Mech/Avio	Test several systems due to partial flight deck dismantling	71	71
	Total manhours per aircraft	**1925**	**1746**
Mech/Avio	Inspection mechanics/avionics	228	192
Sht.mtl.	Inspection sheetmetal	78	78
	Round off/unforeseen work	269	233
	Total manhours including inspection	**2500**	**2250**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: SMALL (Boeing 737)	Description: Ground Based Inerting Systems	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	11	0
Mech.	Defuel and drain CW tank	3	0
Mech.	Open, ventilate and close after modification CW tank	14	0
Avio.	Open/close aft side of E/E	3	0
Mech.	Remove/reinstall RH seats, carpet, floorpanels above RH cable raceway	29	0
Avio.	Remove/reinstall floorprox,seat to seat cables and raceways RH	14	0
Mech.	Remove/reinstall ceiling panels in aft cargo compt. for access to cable raceways	7	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	43	0
Mech.	Clean various locations before modification	44	43
Avio.	Install wiring between flight deck, E/E and new components located in tail cone	179	157
Sht.mtl.	Install feed through structural provisions in CW tank aft skin	179	157
Sht.mtl.	Install provisions for distribution manifold in CW tank	57	57
Mech.	Install distribution manifold in CW tank	100	100
Sht.mtl.	Install provisions for thermal relief valve and isolation valve installation	14	14
Mech.	Install thermal relief valve and isolation valve	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	57	57
Sht.mtl.	Inst. provisions for double wall pipe,witness drain etc. from fill panel to CW tank	14	14
Mech.	Inst. double wall pipe,witness drain etc. from fill panel to CW tank	21	21
Mech/Avio	Test ground based distribution system (3x)	29	29
Mech/Avio	Test several systems due to partial flight deck dismantling	100	100
	Total manhours per aircraft	**925**	**757**
Mech/Avio	Inspection mechanics/avionics	121	96
Sht.mtl.	Inspection sheetmetal	32	32
	Round off/unforeseen work	122	122
	Total manhours including inspection	**1200**	**1050**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: SMALL *(Boeing 737)*	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** MEMBRANE	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	20	0
Mech.	Defuel and drain all fuel tanks	14	0
Mech.	Open, ventilate and close after modification all fuel tanks	31	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	14	14
Mech.	Remove/install several sidewall and ceiling panels in aft. cargo compt.R.H.	20	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in main cabin R.H.	21	0
Avio.	Remove/install floor prox etc in main cabin R.H.	7	0
Avio.	Open/close aft side of E/E	3	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	29	0
Mech.	Clean various locations before and after modification	29	29
Avio.	Install wiring between flight deck,E/E and new components located in tail cone	214	214
Sht.mtl.	Install provisions for filter installation in Aft cargo compt. RH	36	36
Mech.	Install filter assy and element	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	64	64
Mech.	Install shut off valve and filter to shut off valve ducting	7	7
Sht.mtl.	Install provision for compressor installation in tail cone	36	36
Mech.	Install compressor and shut off valve to compressor ducting	10	10
Sht.mtl.	Install provisions for bleed air items	29	29
Sht.mtl.	Install provisions for header/ heat exchanger installation in tail cone	57	57
Mech.	Install header assy, bleed air items and compressor to header assy ducting	29	29
Mech.	Install heat exchanger on header assy	7	7
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	71	71
Mech.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Sht.mtl.	Install provisions for electrically driven cooling fan installation	10	10
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for water seperator/filter, low flow ASM and high flow ASM installation	129	129
Mech.	Install water seperator/filter, low flow ASM and high flow ASM systems	29	24
Avio.	Install water seperator/filter, low flow ASM and high flow ASM systems	29	24
Mech.	Install ducting from heat exch.to water seperator/filter, low flow/high flow ASM systems	21	21
Mech.	Install HX bypass valve and ducting	5	5
Sht.mtl.	Install provisions for high flow valve and relief valve installation	21	21
Mech.	Install high flow valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in CW tank	121	121
Sht.mtl.	Install feed through and shut off valve provisions in fuselage skin (tail cone to cabin)	64	64
Mech.	Install ducting from relief valve to CW tank	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 3 fuel tanks	107	107
Mech.	Install NEA gas distribution system in all 3 fuel tanks	214	214
Mech/Avio	Test cryogenic distillation system (3x)	50	50
Mech/Avio	Test several systems due to partial flight deck dismantling	64	64
	Total manhours per aircraft	**1701**	**1531**
Mech/Avio	Inspection mechanics/avionics	191	157
Sht.mtl.	Inspection sheetmetal	75	75
	Round off/unforeseen work	234	188
	Total manhours including inspection	**2200**	**1950**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: SMALL (Boeing 737)	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** PRESSURE SWING ABSORBTION	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	20	0
Mech.	Defuel and drain all fuel tanks	14	0
Mech.	Open, ventilate and close after modification all fuel tanks	31	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	14	14
Mech.	Remove/install several sidewall and ceiling panels in aft. cargo compt.R.H.	20	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in main cabin R.H.	21	0
Avio.	Remove/install floor prox etc in main cabin R.H.	7	0
Avio.	Open/close aft side of E/E	3	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	29	0
Mech.	Clean various locations before and after modification	36	36
Avio.	Install wiring between flight deck, E/E and new components located in tail cone	214	214
Sht.mtl.	Install provisions for filter installation in bulk cargo compt. RH	36	36
Mech.	Install filter assy and element	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	64	64
Mech.	Install shut off valve and filter to shut off valve ducting	7	7
Sht.mtl.	Install provision for compressor installation in tail cone	36	36
Mech.	Install compressor and shut off valve to compressor ducting	10	10
Sht.mtl.	Install provisions for bleed air items	29	29
Sht.mtl.	Install provisions for header/ heat exchanger installation in tail cone	57	57
Mech.	Install header assy, bleed air items and compressor to header assy ducting	29	29
Mech.	Install heat exchanger on header assy	7	7
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	71	71
Mech.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Sht.mtl.	Install provisions for electrically driven cooling fan installation	10	10
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for water seperator/filter and ASM installation	93	93
Mech.	Install water seperator/filter and ASM systems	19	19
Avio.	Install water seperator/filter and ASM systems	19	19
Mech.	Install ducting from heat exch.to water seperator/filter, low flow/high flow ASM systems	21	21
Mech.	Install HX bypass valve and ducting	5	5
Sht.mtl.	Install provisions for high flow valve and relief valve installation	21	21
Mech.	Install high flow valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in CW tank	121	121
Sht.mtl.	Install feed through and shut off valve provisions in fuselage skin (tail cone to cabin)	64	64
Mech.	Install ducting from relief valve to CW tank	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 3 fuel tanks	107	107
Mech.	Install NEA gas distribution system in all 3 fuel tanks	214	214
Mech/Avio	Test PSA system (3x)	50	50
Mech/Avio	Test several systems due to partial flight deck dismantling	64	64
	Total manhours per aircraft	**1651**	**1490**
Mech/Avio	Inspection mechanics/avionics	188	156
Sht.mtl.	Inspection sheetmetal	71	71
	Round off/unforeseen work	240	183
	Total manhours including inspection	**2150**	**1900**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: SMALL (Boeing 737)	Description: **ON-BOARD INERTING GAS GENERATING SYSTEM** CRYOGENIC	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	20	0
Mech.	Defuel and drain all fuel tanks	14	0
Mech.	Open, ventilate and close after modification all fuel tanks	31	0
Mech.	Remove/install various internal fuel tank panels LH and RH for access	14	14
Mech.	Remove/install several sidewall and ceiling panels in aft. cargo compt.R.H.	20	0
Mech.	Remove/install several insulation blankets R.H.	14	0
Mech.	Remove/install several seats, floorcovering and floorpanels in main cabin R.H.	21	0
Avio.	Remove/install floor prox etc in main cabin R.H.	7	0
Avio.	Open/close aft side of E/E	3	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	29	0
Mech.	Clean various locations before and after modification	36	36
Avio.	Install wiring between flight deck,E/E and new components located in tail cone	214	214
Sht.mtl.	Install provisions for filter installation in aft cargo compt.RH	36	36
Mech.	Install filter assy and element	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	64	64
Mech.	Install shut off valve and filter to shut off valve ducting	7	7
Sht.mtl.	Install provision for compressor installation in Tail Cone	36	36
Mech.	Install compressor and shut off valve to compressor ducting	10	10
Sht.mtl.	Install provisions for bleed air items	29	29
Sht.mtl.	Install provisions for header/ heat exchanger installation in tail cone	57	57
Mech.	Install header assy, bleed air items and compressor to header assy ducting	29	29
Mech.	Install heat exchanger on header assy	7	7
Sht.mtl.	Drill and fit new ram air inlet/outlet fairing panels	71	71
Mech.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Avio.	Assemble and install ram air inlet/outlet panels,doors and motors	14	14
Sht.mtl.	Install provisions for electrically driven cooling fan installation	10	10
Avio.	Install cooling fan to ram air exit	7	7
Sht.mtl.	Install provisions for storage syst.,cryogenic refrigerator and distillation syst.installation	171	171
Mech.	Install storage,cryogenic refrigerator and distillation systems	36	36
Avio.	Install storage,cryogenic refrigerator and distillation systems	36	36
Mech.	Install ducting from heat exchanger to refrigerator,distillation and storage systems	21	21
Mech.	Install HX bypass valve and ducting	5	5
Sht.mtl.	Install provisions for modulating valve and relief valve installation	21	21
Mech.	Install modulating valve, relief valve and ducting	14	14
Sht.mtl.	Install feed through structural provision in CW tank	121	121
Sht.mtl.	Install feed through and shut off valve provisions in fuselage skin (tail cone to cabin)	64	64
Mech.	Install ducting from relief valve to CW tank	14	14
Sht.mtl.	Install provisions for NEA gas distribution ducts in all 3 fuel tanks	107	107
Mech.	Install NEA gas distribution system in all 3 fuel tanks	214	214
Mech/Avio	Test cryogenic distillation system (3x)	50	50
Mech/Avio	Test several systems due to partial flight deck dismantling	64	64
	Total manhours per aircraft	**1764**	**1603**
Mech/Avio	Inspection mechanics/avionics	195	163
Sht.mtl.	Inspection sheetmetal	79	79
	Round off/unforeseen work	212	205
	Total manhours including inspection	**2250**	**2050**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: SMALL *(Boeing 737)*	Description: **Ground Based Inerting Systems**	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	11	0
Mech.	Defuel and drain CW tank	3	0
Mech.	Open, ventilate and close after modification CW tank	14	0
Avio.	Open/close aft side of E/E	3	0
Mech.	Remove/reinstall RH seats, carpet, floorpanels above RH cable raceway	29	0
Avio.	Remove/reinstall floorprox,seat to seat cables and raceways RH	14	0
Mech.	Remove/reinstall ceiling panels in aft cargo compt. for access to cable raceways	7	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	43	0
Mech.	Clean various locations before modification	44	43
Avio.	Install wiring between flight deck, Avionics comp. and new components in center section	157	157
Sht.mtl.	Install feed through structural provisions in CW tank aft skin	157	157
Sht.mtl.	Install provisions for distribution manifold in CW tank	57	57
Mech.	Install distribution manifold in CW tank	100	100
Sht.mtl.	Install provisions for thermal relief valve and isolation valve installation	14	14
Mech.	Install thermal relief valve and isolation valve	7	7
Sht.mtl.	Modify lwr. panel for fill adaptor/components	14	14
Mech.	Inst. double wall pipe,witness drain etc. from fill panel to CW tank	21	21
Mech/Avio	Test ground based distribution system (3x)	29	29
Mech/Avio	Test several systems due to partial flight deck dismantling	100	100
	Total manhours per aircraft	**824**	**699**
Mech/Avio	Inspection mechanics/avionics	116	91
Sht.mtl.	Inspection sheetmetal	24	24
	Round off/unforeseen work	135	85
	Total manhours including inspection	**1100**	**900**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

Airplane type: SMALL *(Boeing 737)*	Description: **Ground Based Inerting Systems**	Special Program	Heavy Check
Skill	**Description**	**labor hours**	**labor hours**
	Accomplishment:		
Mech.	Dock and undock airplane and raise and lower airplane	11	0
Mech.	Defuel and drain CW tank	3	0
Mech.	Open, ventilate and close after modification CW tank	14	0
Avio.	Open/close aft side of E/E	3	0
Mech.	Remove/reinstall RH seats, carpet, floorpanels above RH cable raceway	29	0
Avio.	Remove/reinstall floorprox,seat to seat cables and raceways RH	14	0
Mech.	Remove/reinstall ceiling panels in aft cargo compt. for access to cable raceways	7	0
Avio.	Remove/install Captain seat and several panels/linings in flight deck	43	0
Mech.	Clean various locations before modification	44	43
Avio.	Install wiring between flight deck, Avionics comp. and new components in center section	157	157
Mech.	Remove, install and leak-check 7 center wing bagtank cells	150	150
Shop	Modify 7 CW bagtank cells	150	150
Sht.mtl.	Install feed through structural provisions in CW tank aft skin	157	157
Sht.mtl.	Install provisions for distribution manifold in CW tank	150	150
Mech.	Install distribution manifold in CW tank	100	100
Mech.	Modify lwr. panel for fill adaptor/components	100	100
Sht.mtl.	Install provisions for thermal relief valve and isolation valve installation	14	14
Mech.	Install thermal relief valve and isolation valve	7	7
Sht.mtl.	Inst. provisions for double wall pipe,witness drain etc. from fill panel to CW tank	14	14
Mech.	Inst. double wall pipe,witness drain etc. from fill panel to CW tank	21	21
Mech/Avio	Test ground based distribution system (3x)	29	29
Mech/Avio	Test several systems due to partial flight deck dismantling	100	100
	Total manhours per aircraft	**1317**	**1192**
Mech/Avio	Inspection mechanics/avionics	196	171
Sht.mtl.	Inspection sheetmetal	34	34
	Round off/unforeseen work	203	153
	Total manhours including inspection	**1750**	**1550**
	NOTE: LABOR-HOURS BASED ON MINIMUM INFORMATION !!!		

ADDENDUM F.A.3

MODIFICATION LABOR-HOUR ESTIMATION for BUSSINESS JETS

to

APPENDIX F

AIRPLANE OPERATION AND MAINTENANCE FINAL REPORT

ExecutiveJet
NETJETS®

Mark S. Reed
Sr. Vice President
Maintenance

April 23, 2001

RE: NPRM for Fuel System Modifications (Nitrogen Inerting)

Dear Mr. Peters,

Attached you will find several documents compiled by our Quality Control and Maintenance Scheduling departments. They expand on the information we briefly discussed during our conversation on April 18th. Hopefully, this material will improve your technical familiarity with the business-class aircraft we operate.

In the attachments you will find:

- A two page matrix showing; aircraft we operate on our air carrier certificate, whether or not they have center line fuel storage, and any potential heat sources adjacent to that fuel storage
- Simple maintenance manual references and diagrams for the systems described above
- A table showing routine fuel tank inspection intervals as well as heavy inspection intervals that would most likely be used to incorporate a major modification to the fuel tanks/system.

One other question presented was "How long would we estimate for a modification of this scope?" Without any engineering data, I can only estimate based on experience with other system changes that I believe would be similar. A very *rough order of magnitude* estimate would be 350 to 500 man-hours, but that is highly speculative.

I hope this information helps. If we can be of any further assistance, feel free to contact us.

Sincerely,

Mark Reed

Executive Jet, Inc.
4111 Bridgeway Ave.
Columbus, OH 43219
Tel. (614) 239-2929
Fax (614) 239-2072
mreed@netjets.com

Executive Jet is a Berkshire Hathaway Inc. company

ADDENDUM F.B.1

SCHEDULED MAINTENANCE TASKS
and
ADDITIONAL LABOR-HOURS

to

APPENDIX F

AIRPLANE OPERATION AND MAINTENANCE
FINAL REPORT

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Task	Interval	Labor-hours
Operational check of entire system	A	3
Operational check of High flow ASM	C	2
Operational check of Low flow ASM	C	2
Functional check of entire system	2C	6
Functional check of Compressor	2C	2
Inspect High Flow Check Valve	2C	1
Inspect High Flow Shut Off Valve	2C	1
Inspect Controller / control card	2C	1
Inspect Oxygen Sensor	2C	1
Remove & Replace Filters	2C	1
Remove & Replace Nitrogen check valves	2C	1
Remove & Replace Heat Exchanger	4C	6
Inspect Manifolds/Ducts	4C	4
Inspect Wiring	4C	4
Inspect Bypass Valve	4C	1
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1
Inspect Fuel Tank Check Valve	4C	1
Inspect Water separator	4C	1
Inspect Bleed Air Check Valve	4C	1
Inspect Bleed Air Shut Off Valve	4C	1
Inspect Compressor check valve	4C	1
Inspect Compressor discharge overheat switch	4C	1
Inspect Cooling fan	4C	1
Inspect Cooling fan overheat sensor	4C	1
Inspect Flow Control Orifice	4C	1
Inspect Heat Exchanger - check valve	4C	1
Inspect Over Temperature sensor	4C	1
Inspect Relief valve	4C	1
Inspect Start Contactor	4C	1
Inspect Unloading Valve	4C	1
Inspect Water separator filter	4C	1

Figure F6.2.1-1 - OBGI Maintenance Tasks - Business Jet Category

Task	Interval	Labor-hours
Operational check of entire system	A	3
Operational check of High flow ASM	C	2
Operational check of Low flow ASM	C	2
Functional check of entire system	2C	6
Functional check of Compressor	2C	2
Inspect High Flow Check Valve	2C	1
Inspect High Flow Shut Off Valve	2C	1
Inspect Controller / control card	2C	1
Inspect Oxygen Sensor	2C	1
Remove & Replace Filters	2C	1
Remove & Replace Nitrogen check valves	2C	1
Remove & Replace Heat Exchanger	4C	6
Inspect Manifolds/Ducts	4C	4
Inspect Wiring	4C	4
Inspect Bypass Valve	4C	1
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1
Inspect Fuel Tank Check Valve	4C	1
Inspect Water separator	4C	1
Inspect Bleed Air Check Valve	4C	1
Inspect Bleed Air Shut Off Valve	4C	1
Inspect Compressor check valve	4C	1
Inspect Compressor discharge overheat switch	4C	1
Inspect Cooling fan	4C	1
Inspect Cooling fan overheat sensor	4C	1
Inspect Flow Control Orifice	4C	1
Inspect Heat Exchanger - check valve	4C	1
Inspect Over Temperature sensor	4C	1
Inspect Relief valve	4C	1
Inspect Start Contactor	4C	1
Inspect Unloading Valve	4C	1
Inspect Water separator filter	4C	1

Figure F6.2.1-3 - OBGI Maintenance Tasks - Turbofan Category

Task	Interval	Labor-hours
Operational check of entire system	A	3
Operational check of High flow ASM	C	2
Operational check of Low flow ASM	C	2
Functional check of entire system	2C	6
Functional check of Compressor	2C	2
Inspect High Flow Check Valve	2C	1
Inspect High Flow Shut Off Valve	2C	1
Inspect Controller / control card	2C	1
Inspect Oxygen Sensor	2C	1
Remove & Replace Filters	2C	1
Remove & Replace Nitrogen check valves	2C	1
Remove & Replace Heat Exchanger	4C	6
Inspect Manifolds/Ducts	4C	6
Inspect Wiring	4C	6
Inspect Bypass Valve	4C	1
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1
Inspect Fuel Tank Check Valve	4C	1
Inspect Water separator	4C	1
Inspect Bleed Air Check Valve	4C	1
Inspect Bleed Air Shut Off Valve	4C	1
Inspect Compressor check valve	4C	1
Inspect Compressor discharge overheat switch	4C	1
Inspect Cooling fan	4C	1
Inspect Cooling fan overheat sensor	4C	1
Inspect Flow Control Orifice	4C	1
Inspect Heat Exchanger - check valve	4C	1
Inspect Over Temperature sensor	4C	1
Inspect Relief valve	4C	1
Inspect Start Contactor	4C	1
Inspect Unloading Valve	4C	1
Inspect Water separator filter	4C	1

Figure F6.2.1-5 - OBGI Maintenance Tasks - Medium Transport Category

Task	Interval	Labor-hours
Operational check of entire system	A	3
Operational check of High flow ASM	C	2
Operational check of Low flow ASM	C	2
Functional check of entire system	2C	6
Functional check of Compressor	2C	2
Inspect High Flow Check Valve	2C	1
Inspect High Flow Shut Off Valve	2C	1
Inspect Controller / control card	2C	1
Inspect Oxygen Sensor	2C	1
Remove & Replace Filters	2C	1
Remove & Replace Nitrogen check valves	2C	1
Remove & Replace Heat Exchanger	4C	6
Inspect Manifolds/Ducts	4C	4
Inspect Wiring	4C	4
Inspect Bypass Valve	4C	1
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1
Inspect Fuel Tank Check Valve	4C	1
Inspect Water separator	4C	1
Inspect Bleed Air Check Valve	4C	1
Inspect Bleed Air Shut Off Valve	4C	1
Inspect Compressor check valve	4C	1
Inspect Compressor discharge overheat switch	4C	1
Inspect Cooling fan	4C	1
Inspect Cooling fan overheat sensor	4C	1
Inspect Flow Control Orifice	4C	1
Inspect Heat Exchanger - check valve	4C	1
Inspect Over Temperature sensor	4C	1
Inspect Relief valve	4C	1
Inspect Start Contactor	4C	1
Inspect Unloading Valve	4C	1
Inspect Water separator filter	4C	1

Figure F6.2.1-2 - OBGI Maintenance Tasks - Turboprop Category

Task	Interval	Labor-hours
Operational check of entire system	A	3
Operational check of High flow ASM	C	2
Operational check of Low flow ASM	C	2
Functional check of entire system	2C	6
Functional check of Compressor	2C	2
Inspect High Flow Check Valve	2C	1
Inspect High Flow Shut Off Valve	2C	1
Inspect Controller / control card	2C	1
Inspect Oxygen Sensor	2C	1
Remove & Replace Filters	2C	1
Remove & Replace Nitrogen check valves	2C	1
Remove & Replace Heat Exchanger	4C	6
Inspect Manifolds/Ducts	4C	4
Inspect Wiring	4C	4
Inspect Bypass Valve	4C	1
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1
Inspect Fuel Tank Check Valve	4C	1
Inspect Water separator	4C	1
Inspect Bleed Air Check Valve	4C	1
Inspect Bleed Air Shut Off Valve	4C	1
Inspect Compressor check valve	4C	1
Inspect Compressor discharge overheat switch	4C	1
Inspect Cooling fan	4C	1
Inspect Cooling fan overheat sensor	4C	1
Inspect Flow Control Orifice	4C	1
Inspect Heat Exchanger - check valve	4C	1
Inspect Over Temperature sensor	4C	1
Inspect Relief valve	4C	1
Inspect Start Contactor	4C	1
Inspect Unloading Valve	4C	1
Inspect Water separator filter	4C	1

Figure F6.2.1-4 - OBGI Maintenance Tasks - Small Transport Category

Task	Interval	Labor-hours
Operational check of entire system	A	3
Operational check of High flow ASM	C	2
Operational check of Low flow ASM	C	2
Functional check of entire system	2C	6
Functional check of Compressor	2C	2
Inspect High Flow Check Valve	2C	1
Inspect High Flow Shut Off Valve	2C	1
Inspect Controller / control card	2C	1
Inspect Oxygen Sensor	2C	1
Remove & Replace Filters	2C	1
Remove & Replace Nitrogen check valves	2C	1
Remove & Replace Heat Exchanger	4C	6
Inspect Manifolds/Ducts	4C	8
Inspect Wiring	4C	8
Inspect Bypass Valve	4C	1
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1
Inspect Fuel Tank Check Valve	4C	1
Inspect Water separator	4C	1
Inspect Bleed Air Check Valve	4C	1
Inspect Bleed Air Shut Off Valve	4C	1
Inspect Compressor check valve	4C	1
Inspect Compressor discharge overheat switch	4C	1
Inspect Cooling fan	4C	1
Inspect Cooling fan overheat sensor	4C	1
Inspect Flow Control Orifice	4C	1
Inspect Heat Exchanger - check valve	4C	1
Inspect Over Temperature sensor	4C	1
Inspect Relief valve	4C	1
Inspect Start Contactor	4C	1
Inspect Unloading Valve	4C	1
Inspect Water separator filter	4C	1

Figure F6.2.1-6 - OBGI Maintenance Tasks - Large Transport Category

Task	Interval	Labor-hours
Operational check of entire system	A	3
Pressure/Decay Check & rectification	C	24
Functional check of Compressor	C	2
Inspect Bypass Valve	C	1
Inspect Cryo-Cooler	C	1
Inspect Distillation Column - gas valve	C	1
Inspect Distillation Column - liquid valve	C	1
Inspect Fuel Tank Check Valve	C	1
Inspect Inlet Cooler	C	1
Inspect Inlet Recuperator	C	1
Inspect Water separator	C	1
Inspect Bleed Air Check Valve	C	1
Inspect Bleed Air Shut Off Valve	C	1
Inspect Compressor check valve	C	1
Inspect Compressor discharge overheat switch	C	1
Inspect Controller / control card	C	1
Inspect Cooling fan	C	1
Inspect Cooling fan overheat sensor	C	1
Inspect Crycooler bleed air valve	C	1
Inspect Dewar level sensor	C	1
Inspect Heat Exchanger - check valve	C	1
Inspect High Flow Sensor	C	1
Inspect Inlet shutoff valve	C	1
Inspect LNEA Dewar Cooldown Valve	C	1
Inspect Molecular sieve control valve	C	1
Inspect On / Off check valve & High flow fuse	C	1
Inspect Over Temperature sensor	C	1
Inspect Oxygen Sensor	C	1
Inspect Purge Heat Exchanger - Air Valve	C	1
Inspect Purge Heat Exchanger - Waste Valve	C	1
Inspect Relief valve	C	1
Remove & Replace Cabin Filters	C	1
Functional check of entire system	2C	6
Remove & Replace Heat Exchanger	2C	6
Remove & Replace Molecular sieves	2C	4
Inspect Distilltion Column	2C	2
Remove & Replace Nitrogen check valves	2C	1
Inspect Manifolds/Ducts	4C	4
Inspect Wiring	4C	4
Inspect LNEA Dewar	4C	2
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1

Figure F7.2.1-1 - OBIGGS (Cyrogenic) Maintenance Tasks - Small Transport Category

Task	Interval	Labor-hours
Operational check of entire system	A	3
Pressure/Decay Check & rectification	C	24
Functional check of Compressor	C	2
Operational check of High flow ASM	C	2
Operational check of Low flow ASM	C	2
Inspect Bypass Valve	C	1
Inspect Fuel Tank Check Valve	C	1
Inspect Water separator	C	1
Inspect Bleed Air Check Valve	C	1
Inspect Bleed Air Shut Off Valve	C	1
Inspect Compressor check valve	C	1
Inspect Compressor discharge overheat switch	C	1
Inspect Controller / control card	C	1
Inspect Cooling fan	C	1
Inspect Cooling fan overheat sensor	C	1
Inspect Heat Exchanger - check valve	C	1
Inspect High Flow Check Valve	C	1
Inspect High Flow Shut Off Valve	C	1
Inspect Low/High check valve	C	1
Inspect On / Off check valve & High flow fuse	C	1
Inspect Over Temperature sensor	C	1
Inspect Oxygen Sensor	C	1
Inspect Relief valve	C	1
Remove & Replace Cabin Filters	C	1
Inspect Water separator filter	C	1
Functional check of entire system	2C	8
Remove & Replace Heat Exchanger	2C	6
Remove & Replace Nitrogen check valves	2C	1
Inspect Manifolds/Ducts	4C	4
Inspect Wiring	4C	4
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1

Figure F7.2.1-4 - OBIGGS (Membrane) Maintenance Tasks - Small Transport Category

Task	Interval	Labor-hours
Operational check of entire system	A	3
Pressure/Decay Check & rectification	C	24
Functional check of Compressor	C	2
Inspect Bypass Valve	C	1
Inspect Cryo-Cooler	C	1
Inspect Distillation Column - gas valve	C	1
Inspect Distillation Column - liquid valve	C	1
Inspect Fuel Tank Check Valve	C	1
Inspect Inlet Cooler	C	1
Inspect Inlet Recuperator	C	1
Inspect Water separator	C	1
Inspect Bleed Air Check Valve	C	1
Inspect Bleed Air Shut Off Valve	C	1
Inspect Compressor check valve	C	1
Inspect Compressor discharge overheat switch	C	1
Inspect Controller / control card	C	1
Inspect Cooling fan	C	1
Inspect Cooling fan overheat sensor	C	1
Inspect Crycooler bleed air valve	C	1
Inspect Dewar level sensor	C	1
Inspect Heat Exchanger - check valve	C	1
Inspect High Flow Sensor	C	1
Inspect Inlet shutoff valve	C	1
Inspect LNEA Dewar Cooldown Valve	C	1
Inspect Molecular sieve control valve	C	1
Inspect On / Off check valve & High flow fuse	C	1
Inspect Over Temperature sensor	C	1
Inspect Oxygen Sensor	C	1
Inspect Purge Heat Exchanger - Air Valve	C	1
Inspect Purge Heat Exchanger - Waste Valve	C	1
Inspect Relief valve	C	1
Remove & Replace Cabin Filters	C	1
Functional check of entire system	2C	6
Remove & Replace Heat Exchanger	2C	6
Remove & Replace Molecular sieves	2C	4
Inspect Distilltion Column	2C	2
Remove & Replace Nitrogen check valves	2C	1
Inspect Manifolds/Ducts	4C	6
Inspect Wiring	4C	6
Inspect LNEA Dewar	4C	2
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1

Figure F7.2.1-2 - OBIGGS (Cyrogenic) Maintenance Tasks - Medium Transport Category

Task	Interval	Labor-hours
Operational check of entire system	A	3
Pressure/Decay Check & rectification	C	24
Functional check of Compressor	C	2
Operational check of High flow ASM	C	2
Operational check of Low flow ASM	C	2
Inspect Bypass Valve	C	1
Inspect Fuel Tank Check Valve	C	1
Inspect Water separator	C	1
Inspect Bleed Air Check Valve	C	1
Inspect Bleed Air Shut Off Valve	C	1
Inspect Compressor check valve	C	1
Inspect Compressor discharge overheat switch	C	1
Inspect Controller / control card	C	1
Inspect Cooling fan	C	1
Inspect Cooling fan overheat sensor	C	1
Inspect Heat Exchanger - check valve	C	1
Inspect High Flow Check Valve	C	1
Inspect High Flow Shut Off Valve	C	1
Inspect Low/High check valve	C	1
Inspect On / Off check valve & High flow fuse	C	1
Inspect Over Temperature sensor	C	1
Inspect Oxygen Sensor	C	1
Inspect Relief valve	C	1
Remove & Replace Cabin Filters	C	1
Inspect Water separator filter	C	1
Functional check of entire system	2C	8
Remove & Replace Heat Exchanger	2C	6
Remove & Replace Nitrogen check valves	2C	1
Inspect Manifolds/Ducts	4C	6
Inspect Wiring	4C	6
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1

Figure F7.2.1-5 - OBIGGS (Membrane) Maintenance Tasks - Medium Transport Category

Task	Interval	Labor-hours
Operational check of entire system	A	3
Pressure/Decay Check & rectification	C	24
Functional check of Compressor	C	2
Inspect Bypass Valve	C	1
Inspect Cryo-Cooler	C	1
Inspect Distillation Column - gas valve	C	1
Inspect Distillation Column - liquid valve	C	1
Inspect Fuel Tank Check Valve	C	1
Inspect Inlet Cooler	C	1
Inspect Inlet Recuperator	C	1
Inspect Water separator	C	1
Inspect Bleed Air Check Valve	C	1
Inspect Bleed Air Shut Off Valve	C	1
Inspect Compressor check valve	C	1
Inspect Compressor discharge overheat switch	C	1
Inspect Controller / control card	C	1
Inspect Cooling fan	C	1
Inspect Cooling fan overheat sensor	C	1
Inspect Crycooler bleed air valve	C	1
Inspect Dewar level sensor	C	1
Inspect Heat Exchanger - check valve	C	1
Inspect High Flow Sensor	C	1
Inspect Inlet shutoff valve	C	1
Inspect LNEA Dewar Cooldown Valve	C	1
Inspect Molecular sieve control valve	C	1
Inspect On / Off check valve & High flow fuse	C	1
Inspect Over Temperature sensor	C	1
Inspect Oxygen Sensor	C	1
Inspect Purge Heat Exchanger - Air Valve	C	1
Inspect Purge Heat Exchanger - Waste Valve	C	1
Inspect Relief valve	C	1
Remove & Replace Cabin Filters	C	1
Functional check of entire system	2C	6
Remove & Replace Heat Exchanger	2C	6
Remove & Replace Molecular sieves	2C	4
Inspect Distilltion Column	2C	2
Remove & Replace Nitrogen check valves	2C	1
Inspect Manifolds/Ducts	4C	8
Inspect Wiring	4C	8
Inspect LNEA Dewar	4C	2
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1

Figure F7.2.1-3 - OBIGGS (Cyrogenic) Maintenance Tasks - Large Transport Category

Task	Interval	Labor-hours
Operational check of entire system	A	3
Pressure/Decay Check & rectification	C	24
Functional check of Compressor	C	2
Operational check of High flow ASM	C	2
Operational check of Low flow ASM	C	2
Inspect Bypass Valve	C	1
Inspect Fuel Tank Check Valve	C	1
Inspect Water separator	C	1
Inspect Bleed Air Check Valve	C	1
Inspect Bleed Air Shut Off Valve	C	1
Inspect Compressor check valve	C	1
Inspect Compressor discharge overheat switch	C	1
Inspect Controller / control card	C	1
Inspect Cooling fan	C	1
Inspect Cooling fan overheat sensor	C	1
Inspect Heat Exchanger - check valve	C	1
Inspect High Flow Check Valve	C	1
Inspect High Flow Shut Off Valve	C	1
Inspect Low/High check valve	C	1
Inspect On / Off check valve & High flow fuse	C	1
Inspect Over Temperature sensor	C	1
Inspect Oxygen Sensor	C	1
Inspect Relief valve	C	1
Remove & Replace Cabin Filters	C	1
Inspect Water separator filter	C	1
Functional check of entire system	2C	8
Remove & Replace Heat Exchanger	2C	6
Remove & Replace Nitrogen check valves	2C	1
Inspect Manifolds/Ducts	4C	8
Inspect Wiring	4C	8
Inspect Check valve Center wing	4C	1
Inspect Check valve L/H wing	4C	1
Inspect Check valve R/H wing	4C	1

Figure F7.2.1-6 - OBIGGS (Membrane) Maintenance Tasks - Large Transport Category

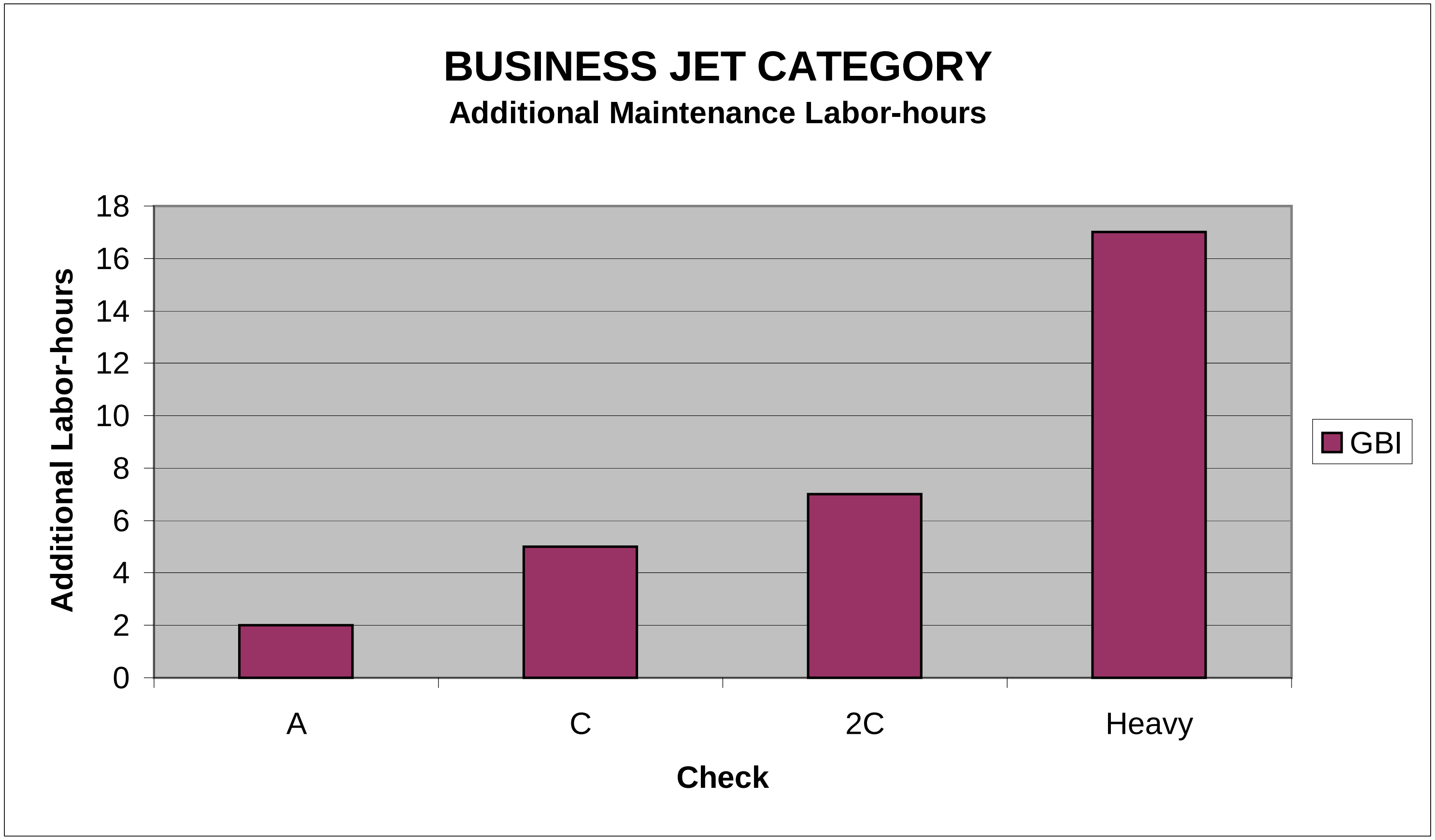

Figure F3.3-1 - Additional Maintenance Labor-hours - Business Jet Category

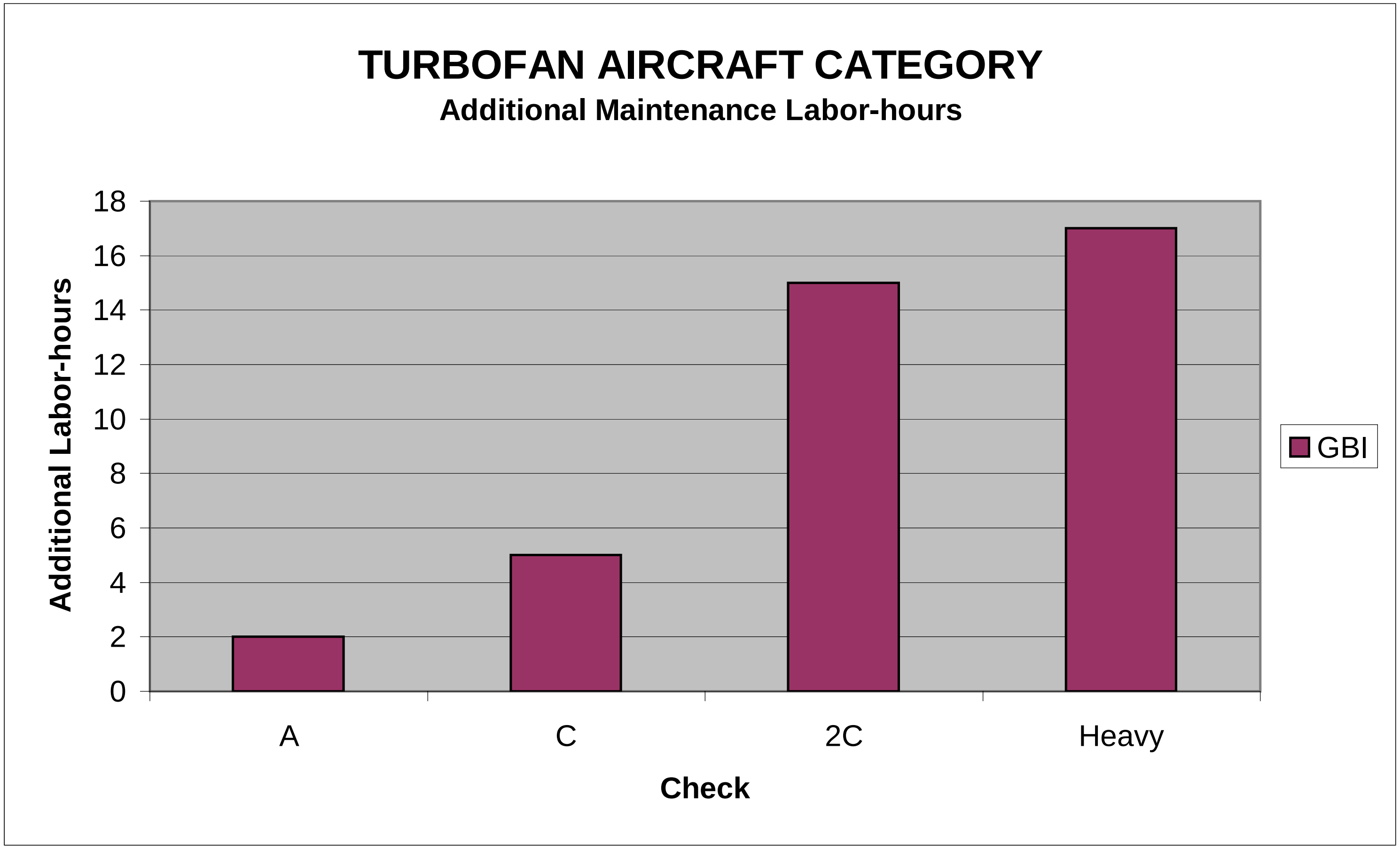

Figure F3.3-2 - Additional Maintenance Labor-hours - Turbofan Category

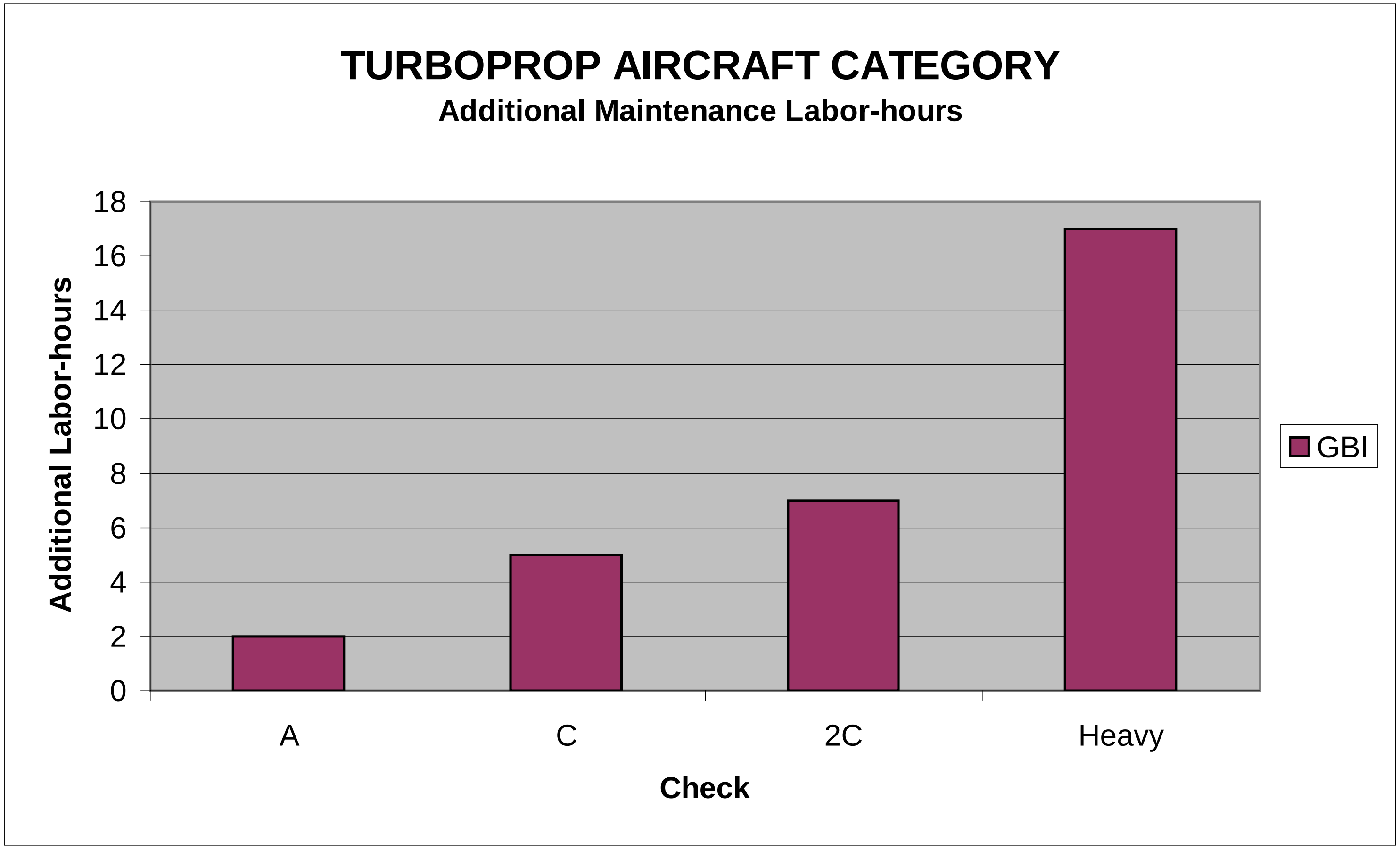

Figure F3.3-3 - Additional Maintenance Labor-hours - Turboprop Category

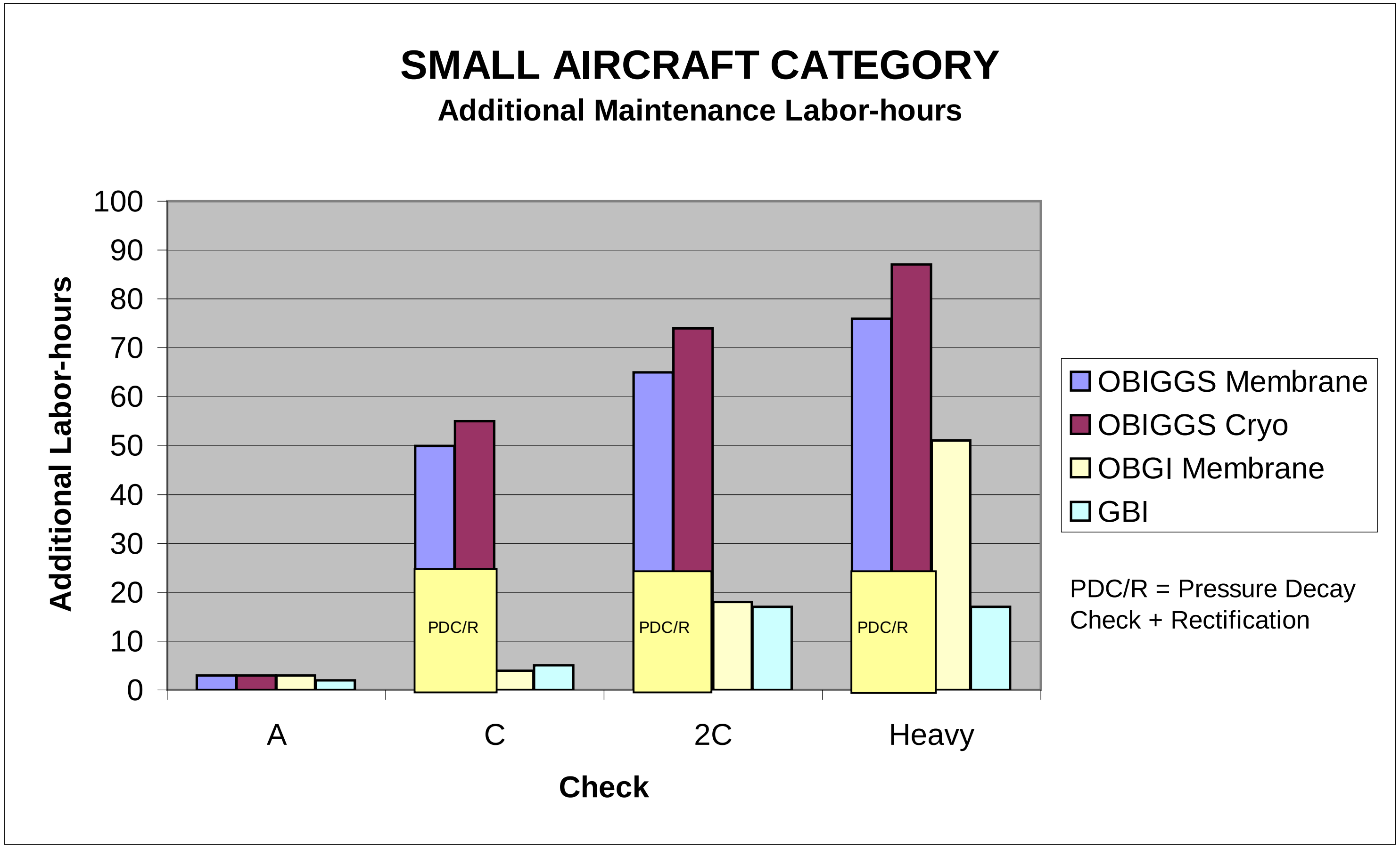

Figure F3.3-4 - Additional Maintenance Labor-hours - Small Aircraft Category

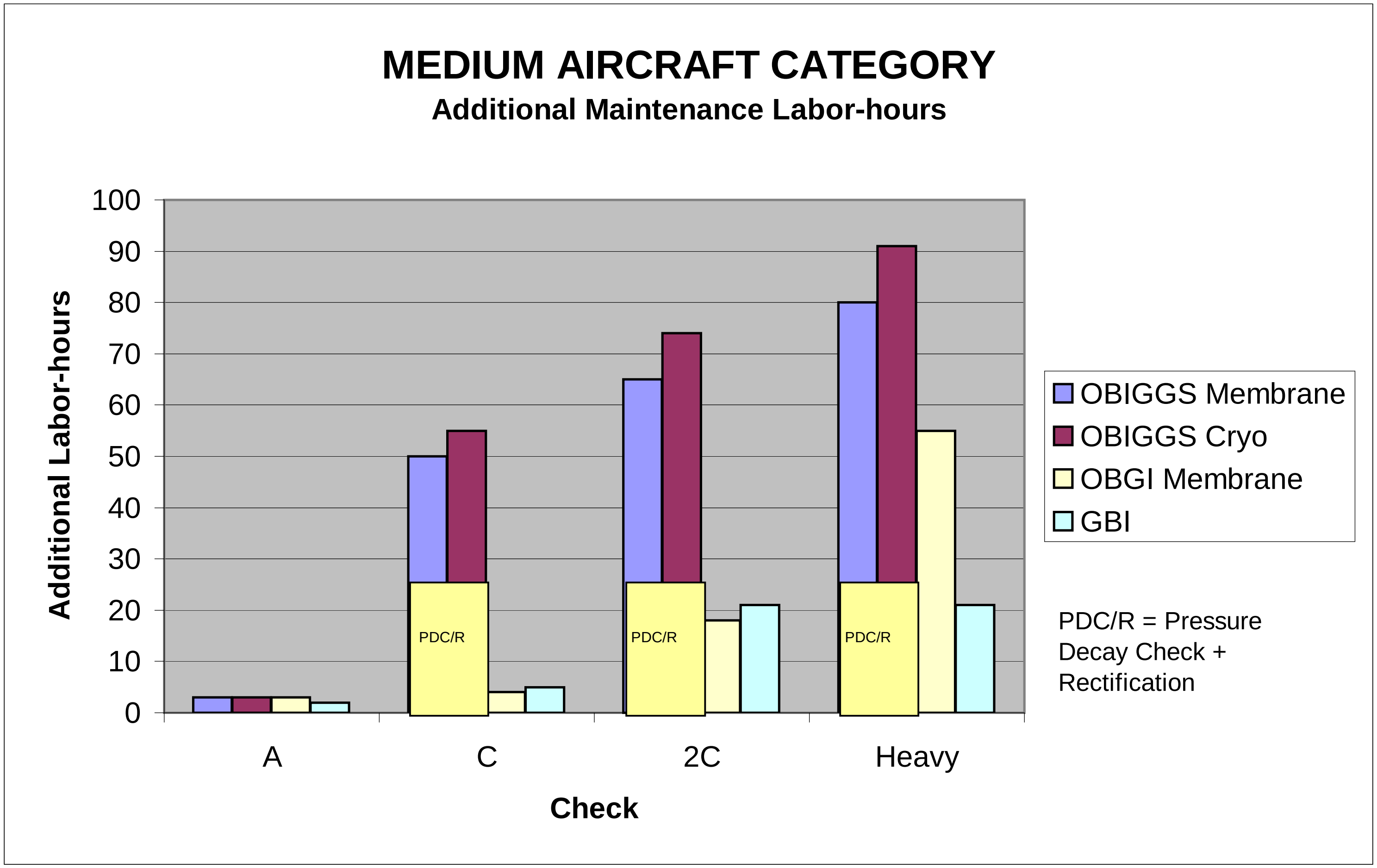

Figure F3.3-5 - Additional Maintenance Labor-hours - Medium Aircraft Category

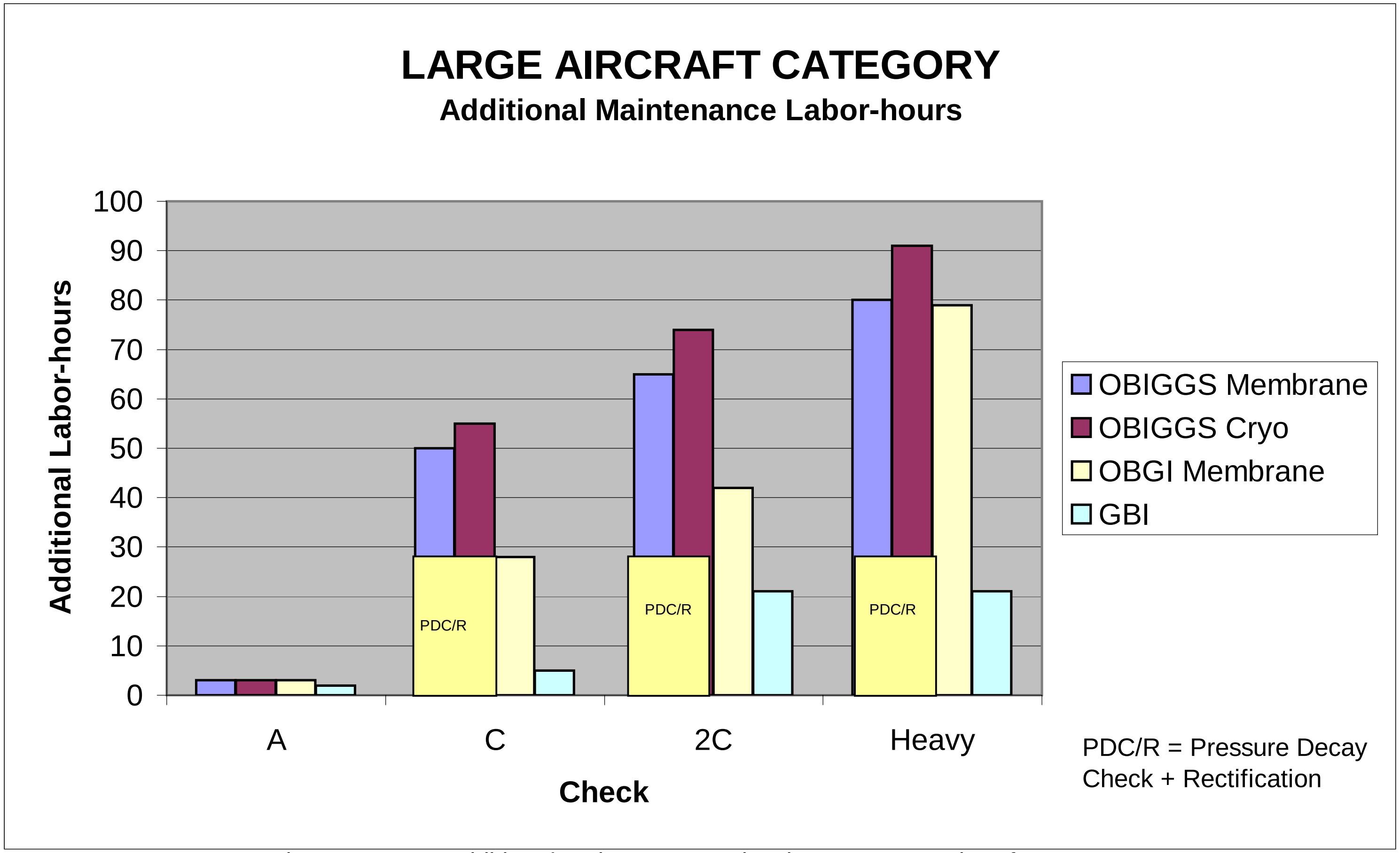

Figure F3.3-6 - Additional Maintenance Labor-hours - Large Aircraft Category

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ADDENDUM F.C.1

UN-SCHEDULED MAINTENANCE DATA
GROUND BASED INERTING SYSTEM

to

APPENDIX F

AIRPLANE OPERATION AND MAINTENANCE
FINAL REPORT

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Large Transport

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year
Isolation valve (including thermal relief valve)	187,770	208,600	1	24,446	24,446	2	7	1	0.17	1.67
Non return valve	362,028	402,253	1	41,995	41,995	1	7	1	0.10	0.87
Self sealing coupling (including frangible fitting)	422,535	469,483	1	80,000	80,000	1	1	0.5	0.05	0.13
Ducting (including double wall pipe and distribution manifold)	10,000,000	10,000,000	1	80,000	80,000	2	2	1	0.05	0.26
Wiring	10,000,000	10,000,000	1	80,000	80,000	1	2	1	0.05	0.20
System Totals			**5**		**9,783**				**0.42**	**3.13**

Medium Transport

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year
Isolation valve (including thermal relief valve)	187,770	208,600	1	24,446	24,446	2	6	1	0.11	1.03
Non return valve	362,028	402,253	1	41,995	41,995	1	6	1	0.07	0.53
Self sealing coupling (including frangible fitting)	422,535	469,483	1	80,000	80,000	1	1	0.5	0.03	0.09
Ducting (including double wall pipe and distribution manifold)	10,000,000	10,000,000	1	80,000	80,000	2	2	1	0.03	0.17
Wiring	10,000,000	10,000,000	1	80,000	80,000	1	2	1	0.03	0.14
System Totals			**5**		**9,783**				**0.29**	**1.96**

Small Transport

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year
Isolation valve (including thermal relief valve)	187,770	208,600	1	24,446	24,446	2	6	1	0.12	1.06

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year
Non return valve	362,028	402,253	1	41,995	41,995	1	6	1	0.07	0.55
Self sealing coupling (including frangible fitting)	422,535	469,483	1	80,000	80,000	1	1	0.5	0.04	0.09
Ducting (including double wall pipe and distribution manifold)	10,000,000	10,000,000	1	80,000	80,000	2	2	1	0.04	0.18
Wiring	10,000,000	10,000,000	1	80,000	80,000	1	2	1	0.04	0.14
System Totals			**5**		**9,783**				**0.29**	**2.02**

Regional Turbofan

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year
Isolation valve (including thermal relief valve)	187,770	208,600	1	24,446	24,446	2	5	1	0.09	0.69
Non return valve	362,028	402,253	1	41,995	41,995	1	5	1	0.05	0.35
Self sealing coupling (including frangible fitting)	422,535	469,483	1	80,000	80,000	1	1	0.5	0.03	0.07
Ducting (including double wall pipe and distribution manifold)	10,000,000	10,000,000	1	80,000	80,000	2	2	1	0.03	0.13
Wiring	10,000,000	10,000,000	1	80,000	80,000	1	2	1	0.03	0.11
System Totals			5		**9,783**				**0.22**	**1.35**

Regional Turboprop

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year
Isolation valve (including thermal relief valve)	187,770	208,600	1	24,446	24,446	2	5	1	0.12	0.97
Non return valve	362,028	402,253	1	41,995	41,995	1	5	1	0.07	0.49
Self sealing coupling (including frangible fitting)	422,535	469,483	1	80,000	80,000	1	1	0.5	0.04	0.09
Ducting (including double wall pipe and distribution manifold)	10,000,000	10,000,000	1	80,000	80,000	2	2	1	0.04	0.18
Wiring	10,000,000	10,000,000	1	80,000	80,000	1	2	1	0.04	0.15
System Totals			5		**9,783**				**0.30**	**1.89**

Business Jet

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year
Isolation valve (including thermal relief valve)	187,770	208,600	1	24,446	24,446	2	6	1	0.02	0.18
Non return valve	362,028	402,253	1	41,995	41,995	1	6	1	0.01	0.10
Self sealing coupling (including frangible fitting)	422,535	469,483	1	80,000	80,000	1	1	0.5	0.01	0.02
Ducting (including double wall pipe and distribution manifold)	10,000,000	10,000,000	1	80,000	80,000	2	2	1	0.01	0.03
Wiring	10,000,000	10,000,000	1	80,000	80,000	1	2	1	0.01	0.03
System Totals			5		**9,783**				**0.05**	**0.35**

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ADDENDUM F.C.2

UN-SCHEDULED MAINTENANCE DATA
ON-BOARD GROUND INERTING SYSTEM

to

APPENDIX F

AIRPLANE OPERATION AND MAINTENANCE
FINAL REPORT

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ON-BOARD GROUND INERTING SYSTEM PARTS LIST

DUAL FLOW MEMBRANE - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Small Transport											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.03	0.09	1.72
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.24	0.72	14.37
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.05	0.10	3.00
Compressor	7,000	100,000	1	11,096	11,096	2	0.5	0.5	0.17	0.52	10.36
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.06	0.17	3.37
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.06	0.18	3.52
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.08	0.25	5.05
Heat exchanger	100,000	100,000	1	11,621	11,621	2	1	1	0.25	0.99	14.81
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.03	0.08	1.96
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.04	0.12	2.41
Temperature sensor	50,000	50,000	2	52,494	26,247	2	2	4	0.11	0.87	6.56
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.05	0.16	3.20
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.48	1.44	28.74
Air separation module	30,000	30,000	1	20,000	20,000	2	1	6	0.10	0.86	5.75
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.04	0.18	2.16
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.11	0.32	6.39
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.14	4.73	8.61
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.19	0.77	11.50
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.04	0.36	2.15
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.04	0.57	2.15
System Totals			25		960	35	44.5	44	2.30	13.48	137.79

ON-BOARD GROUND INERTING SYSTEM PARTS LIST
DUAL FLOW MEMBRANE - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Medium Transport											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.03	0.08	1.26
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.16	0.48	7.19
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.03	0.07	1.50
Compressor	7,000	100,000	1	11,096	11,096	3	0.5	0.5	0.12	0.46	5.18
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.04	0.11	1.68
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.06	0.17	2.57
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.08	0.25	3.68
Heat exchanger	100,000	100,000	1	11,621	11,621	4	1	1	0.24	1.44	10.81
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.02	0.05	0.98
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.03	0.08	1.20
Temperature sensor	50,000	50,000	2	52,494	26,247	1	1	2	0.11	0.43	4.79
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.05	0.16	2.34
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.32	0.96	14.37
Air separation module	30,000	30,000	1	20,000	20,000	9	2	6	0.06	1.09	2.87
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.02	0.12	1.08
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.10	0.31	4.67
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.14	4.61	6.28
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.13	0.51	5.75
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.03	0.35	1.57
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.03	0.56	1.57
System Totals			25		960	44	44.5	42	1.81	12.28	81.35

ON-BOARD GROUND INERTING SYSTEM PARTS LIST

DUAL FLOW MEMBRANE - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Large Transport											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.04	0.12	1.22
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.14	0.41	4.11
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.03	0.06	0.86
Compressor	7,000	100,000	1	11,096	11,096	18	2	1	0.10	2.07	2.96
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.03	0.10	0.96
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.08	0.25	2.51
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.12	0.36	3.59
Heat exchanger	100,000	100,000	1	11,621	11,621	4	1	1	0.35	2.11	10.53
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.02	0.05	0.56
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.02	0.07	0.69
Temperature sensor	50,000	50,000	2	52,494	26,247	1	1	2	0.16	0.62	4.66
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.08	0.23	2.28
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.27	0.82	8.21
Air separation module	30,000	30,000	1	20,000	20,000	18	2	6	0.05	1.42	1.64
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.02	0.10	0.62
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.15	0.45	4.55
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.20	6.73	6.12
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.11	0.44	3.29
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.05	0.51	1.53
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.05	0.82	1.53
System Totals			25		960	68	46	42.5	2.08	17.74	62.41

ON-BOARD GROUND INERTING SYSTEM PARTS LIST
DUAL FLOW MEMBRANE - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Business Jet											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.01	0.02	0.30
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.05	0.14	2.74
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.01	0.02	0.57
Compressor	7,000	100,000	1	11,096	11,096	2	0.5	0.5	0.03	0.10	1.97
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.01	0.03	0.64
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.01	0.03	0.61
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.01	0.04	0.88
Heat exchanger	100,000	100,000	1	11,621	11,621	2	1	1	0.04	0.17	2.58
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.01	0.02	0.37
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.01	0.02	0.46
Temperature sensor	50,000	50,000	2	52,494	26,247	2	2	4	0.02	0.15	1.14
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.01	0.03	0.56
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.09	0.27	5.48
Air separation module	30,000	30,000	1	20,000	20,000	2	1	6	0.02	0.16	1.10
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.01	0.03	0.41
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.02	0.06	1.11
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.03	0.83	1.50
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.05	0.20	3.00
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.01	0.06	0.38
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.01	0.10	0.38
System Totals			25		960	35	44.5	44	0.44	2.48	26.18

ON-BOARD GROUND INERTING SYSTEM PARTS LIST
DUAL FLOW MEMBRANE - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Regional Turboprop											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.02	0.06	1.27
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.13	0.39	7.76
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.03	0.05	1.62
Compressor	7,000	100,000	1	11,096	11,096	2	0.5	0.5	0.09	0.28	5.59
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.03	0.09	1.82
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.04	0.13	2.60
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.06	0.19	3.72
Heat exchanger	100,000	100,000	1	11,621	11,621	2	1	1	0.18	0.73	10.93
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.02	0.04	1.06
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.02	0.06	1.30
Temperature sensor	50,000	50,000	2	52,494	26,247	2	2	4	0.08	0.65	4.84
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.04	0.12	2.36
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.26	0.78	15.51
Air separation module	30,000	30,000	1	20,000	20,000	2	1	6	0.05	0.47	3.10
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.02	0.10	1.16
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.08	0.24	4.72
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.05	1.71	3.10
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.21	0.85	12.70
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.03	0.26	1.59
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.03	0.42	1.59
System Totals			25		960	35	44.5	44	1.47	7.61	88.35

ON-BOARD GROUND INERTING SYSTEM PARTS LIST
DUAL FLOW MEMBRANE - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Regional Turbofan											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.03	0.09	1.77
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.13	0.40	8.10
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.03	0.06	1.69
Compressor	7,000	100,000	1	11,096	11,096	2	0.5	0.5	0.10	0.29	5.84
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.03	0.09	1.90
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.06	0.18	3.63
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.09	0.26	5.20
Heat exchanger	100,000	100,000	1	11,621	11,621	2	1	1	0.25	1.02	15.26
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.02	0.05	1.11
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.02	0.07	1.36
Temperature sensor	50,000	50,000	2	52,494	26,247	2	2	4	0.11	0.90	6.76
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.05	0.16	3.30
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.27	0.81	16.20
Air separation module	30,000	30,000	1	20,000	20,000	2	1	6	0.05	0.49	3.24
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.02	0.10	1.22
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.11	0.33	6.59
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.15	4.88	8.87
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.30	1.18	17.74
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.04	0.37	2.22
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.04	0.59	2.22
System Totals			25		960	35	44.5	44	1.90	12.32	114.20

ON-BOARD GROUND INERTING SYSTEM PARTS LIST

THREE-FLOW PRESSURE-SWING ADSORPTION - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Small Transport											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.03	0.09	1.72
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.24	0.72	14.37
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.05	0.10	3.00
Compressor	7,000	100,000	1	11,096	11,096	2	1	0.5	0.17	0.60	10.36
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.06	0.17	3.37
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.06	0.18	3.52
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.08	0.25	5.05
Heat exchanger	100,000	100,000	1	11,621	11,621	2	1	1	0.25	0.99	14.81
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.03	0.08	1.96
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.04	0.12	2.41
Temperature sensor	50,000	50,000	2	52,494	26,247	1	1	2	0.11	0.44	6.56
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.05	0.16	3.20
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.48	1.44	28.74
Air separation module	34,000	34,000	1	15,000	15,000	2	1	6	0.13	1.15	7.67
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.04	0.18	2.16
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.11	0.32	6.39
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.14	4.73	8.61
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.29	1.15	17.21
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.04	0.36	2.15
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.04	0.57	2.15
System Totals			25		945	34	44	42	2.42	13.79	145.42

ON-BOARD GROUND INERTING SYSTEM PARTS LIST

THREE-FLOW PRESSURE-SWING ADSORPTION - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Medium Transport											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.03	0.08	1.26
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.16	0.48	7.19
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.03	0.07	1.50
Compressor	7,000	100,000	1	11,096	11,096	3	0.5	0.5	0.12	0.46	5.18
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.04	0.11	1.68
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.06	0.17	2.57
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.08	0.25	3.68
Heat exchanger	100,000	100,000	1	11,621	11,621	4	1	1	0.24	1.44	10.81
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.02	0.05	0.98
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.03	0.08	1.20
Temperature sensor	50,000	50,000	2	52,494	26,247	1	1	2	0.11	0.43	4.79
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.05	0.16	2.34
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.32	0.96	14.37
Air separation module	34,000	34,000	1	15,000	15,000	9	2	6	0.09	1.45	3.83
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.02	0.12	1.08
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.05	0.14	2.13
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.14	4.61	6.28
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.28	1.12	12.57
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.03	0.35	1.57
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.03	0.56	1.57
System Totals			25		945	44	44.5	42	1.92	13.08	86.59

ON-BOARD GROUND INERTING SYSTEM PARTS LIST

THREE-FLOW PRESSURE-SWING ADSORPTION - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Large Transport											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.04	0.12	1.22
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.14	0.41	4.11
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.03	0.06	0.86
Compressor	7,000	100,000	1	11,096	11,096	20	3	1	0.10	2.37	2.96
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.03	0.10	0.96
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.08	0.25	2.51
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.12	0.36	3.59
Heat exchanger	100,000	100,000	1	11,621	11,621	9	2	1	0.35	4.21	10.53
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.02	0.05	0.56
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.02	0.07	0.69
Temperature sensor	50,000	50,000	2	52,494	26,247	1	1	2	0.16	0.62	4.66
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.08	0.23	2.28
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.27	0.82	8.21
Air separation module	34,000	34,000	1	15,000	15,000	18	2	6	0.07	1.90	2.19
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.02	0.10	0.62
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.15	0.45	4.55
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.20	6.73	6.12
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.41	1.63	12.24
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.05	0.51	1.53
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.05	0.82	1.53
System Totals			25		945	75	48	42.5	2.40	21.81	71.92

ON-BOARD GROUND INERTING SYSTEM PARTS LIST

THREE-FLOW PRESSURE-SWING ADSORPTION - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Business Jet											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.01	0.02	0.30
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.05	0.14	2.74
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.01	0.02	0.57
Compressor	7,000	100,000	1	11,096	11,096	2	1	0.5	0.03	0.12	1.97
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.01	0.03	0.64
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.01	0.03	0.61
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.01	0.04	0.88
Heat exchanger	100,000	100,000	1	11,621	11,621	2	1	1	0.04	0.17	2.58
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.01	0.02	0.37
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.01	0.02	0.46
Temperature sensor	50,000	50,000	2	52,494	26,247	1	1	2	0.02	0.08	1.14
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.01	0.03	0.56
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.09	0.27	5.48
Air separation module	34,000	34,000	1	15,000	15,000	2	1	6	0.02	0.22	1.46
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.01	0.03	0.41
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.02	0.06	1.11
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.03	0.83	1.50
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.05	0.20	3.00
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.01	0.06	0.38
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.01	0.10	0.38
System Totals			25		945	34	44	42	0.44	2.48	26.54

ON-BOARD GROUND INERTING SYSTEM PARTS LIST

THREE-FLOW PRESSURE-SWING ADSORPTION - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Regional Turboprop											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.02	0.06	1.27
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.13	0.39	7.76
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.03	0.05	1.62
Compressor	7,000	100,000	1	11,096	11,096	2	1	0.5	0.09	0.33	5.59
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.03	0.09	1.82
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.04	0.13	2.60
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.06	0.19	3.72
Heat exchanger	100,000	100,000	1	11,621	11,621	2	1	1	0.18	0.73	10.93
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.02	0.04	1.06
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.02	0.06	1.30
Temperature sensor	50,000	50,000	2	52,494	26,247	1	1	2	0.08	0.32	4.84
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.04	0.12	2.36
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.26	0.78	15.51
Air separation module	34,000	34,000	1	15,000	15,000	2	1	6	0.07	0.62	4.14
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.02	0.10	1.16
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.08	0.24	4.72
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.11	3.49	6.35
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.21	0.85	12.70
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.03	0.26	1.59
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.03	0.42	1.59
System Totals			25		945	34	44	42	1.54	9.27	92.63

ON-BOARD GROUND INERTING SYSTEM PARTS LIST

THREE-FLOW PRESSURE-SWING ADSORPTION - Reliability Estimate Data

Component	Unit MTBMA	Unit MTBF	Quantity /Shipset	Single Component MTBUR Calc (Hrs)	Component MTBUR Calc (System) (Hrs)	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labor Hours Per Year	Delays Per Year (Minutes)
Regional Turbofan											
Cabin air filter assy	100,000	100,000	1	100,000	100,000	1	1	1	0.03	0.09	1.77
Cabin air filter element	4,000	10,000,000	1	8,000	8,000	1	1	1	0.13	0.40	8.10
Compressor unloading valve	50,000	50,000	1	38,315	38,315	1	0.5	0.5	0.03	0.06	1.69
Compressor	7,000	100,000	1	11,096	11,096	2	1	0.5	0.10	0.34	5.84
Compressor discharge check valve	100,000	100,000	1	34,119	34,119	1	0.5	1.5	0.03	0.09	1.90
Bleed shutoff valve	50,000	50,000	1	48,856	48,856	1	1	1	0.06	0.18	3.63
Bleed check valve	100,000	100,000	1	34,119	34,119	1	1	1	0.09	0.26	5.20
Heat exchanger	100,000	100,000	1	11,621	11,621	2	1	1	0.25	1.02	15.26
Cooling fan	25,000	25,000	1	58,561	58,561	1	1	0.5	0.02	0.05	1.11
Bypass valve	50,000	50,000	1	47,737	47,737	1	1	1	0.02	0.07	1.36
Temperature sensor	50,000	50,000	2	52,494	26,247	1	1	2	0.11	0.45	6.76
Water separator/filter assy	100,000	100,000	1	53,789	53,789	1	1	1	0.05	0.16	3.30
Water separator/filter element	4,000	10,000,000	1	4,000	4,000	1	1	1	0.27	0.81	16.20
Air separation module	34,000	34,000	1	15,000	15,000	2	1	6	0.07	0.65	4.32
Relief valve	50,000	50,000	1	53,306	53,306	2	1	2	0.02	0.10	1.22
Oxygen sensor	26,933	26,933	1	26,933	26,933	1	1	1	0.11	0.33	6.59
Fuel tank check valve	100,000	100,000	5	100,000	20,000	1	24	8	0.15	4.88	8.87
Controller / control card	10,000	10,000	1	10,000	10,000	1	1	2	0.30	1.18	17.74
Ducting	10,000,000	10,000,000	1	80,000	80,000	6	2	2	0.04	0.37	2.22
Wiring	10,000,000	10,000,000	1	80,000	80,000	6	2	8	0.04	0.59	2.22
System Totals			25		945	34	44	42	1.92	12.08	115.28

ADDENDUM F.C.3

UN-SCHEDULED MAINTENANCE DATA
ON-BOARD INERTING GAS GENERATING SYSTEM

to

APPENDIX F

AIRPLANE OPERATION AND MAINTENANCE
FINAL REPORT

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OBIGGS Data Sheet

Variable Input

	Aircraft Daily Utilization Rate - Flt Hrs	Aircraft Cycles Per Day	Minimum Turn Time Minutes	Minimum Daily Operating Hours (Includes Ground Ops Time)	Minimum Yearly Operating Hours (Includes Ground Ops Time)	Aircraft Annual Flight Hours	Aircraft pressure Check (Hours)
Small Transport	7.86	7	30	11	4146	2869	0
Medium Transport	7.65	4	45	10	3750	2792	0
Large Transport	11.18	2	60	13	4811	4081	0
Business Jet	1.37	4	60	5	1778	500	0
Regional Turboprop	5.8	7	15	8	2765	2117	0
Regional Turbofan	8.1	7	15	10	3577	2957	0

	Labour Costs $	Delay Assumption - 1 delay = XX Minutes	Cost Per Minute Delay ($)	Minutes delay due to extended turn time	Delay Costs $ per hr	Cancelation Costs $ per event	Cancelation Costs $ per day
Small Transport	$75	60	$100	5	$6,000.00	$7,600	$53,200
Medium Transport	$75	45	$142	5	$8,490.00	$20,000	$70,000
Large Transport	$75	30	$183	5	$10,980.00	$32,600	$65,200
Business Jet	$75	60	$100	5	$6,000.00	$7,600	$26,600
Regional Turboprop	$75	60	$100	5	$6,000.00	$7,600	$53,960
Regional Turbofan	$75	60	$100	5	$6,000.00	$7,600	$51,680

MMEL Relief Study

	MMEL Repair Interval/ Service Cancellation				
	None	1 day	3 days	10 days	120 days
Small Transport	90%	20%	5%	3%	0%
Medium Transport	80%	18%	4%	2%	0%
Large Transport	70%	15%	3%	1%	0%
Business Jet	80%	18%	4%	2%	0%
Regional Turboprop	90%	20%	5%	3%	0%
Regional Turbofan	90%	20%	5%	3%	0%

	MMEL Impact No relief - Costs $			Cancelation Costs	Delay Costs
	Membrane System	PSA System	Cryo System	$ per day	$ per hr
Small Transport	$137,662.84	$143,719.28	$197,480.10	$26,600	$6,000
Medium Transport	$164,216.51	$171,441.17	$235,571.87	$35,000	$8,490
Large Transport	$265,267.43	$276,937.80	$380,531.43	$65,200	$10,980
Business Jet	$66,419.23	$69,341.33	$95,279.72	$13,300	$6,000
Regional Turboprop	$139,581.37	$145,722.21	$200,232.26	$26,980	$6,000
Regional Turbofan	$133,825.78	$139,713.41	$191,975.76	$25,840	$6,000

	MMEL Impact 1 day relief - Costs $			Cancelation Costs	Delay Costs
	Membrane System	PSA System	Cryo System	$ per day	$ per hr
Small Transport	$56,770.49	$59,268.10	$81,438.41	$26,600	$6,000
Medium Transport	$64,631.69	$67,475.15	$92,715.46	$35,000	$8,490
Large Transport	$81,041.00	$84,606.38	$116,254.94	$65,200	$10,980
Business Jet	$41,029.58	$42,834.67	$58,857.76	$13,300	$6,000
Regional Turboprop	$57,196.83	$59,713.19	$82,050.00	$26,980	$6,000
Regional Turbofan	$55,917.82	$58,377.90	$80,215.22	$25,840	$6,000

	MMEL Impact 3 day relief - Costs $			Cancelation Costs	Delay Costs
	Membrane System	PSA System	Cryo System	$ per day	$ per hr
Small Transport	$39,436.42	$41,171.42	$56,572.33	$26,600	$6,000
Medium Transport	$41,823.56	$43,663.57	$59,996.73	$35,000	$8,490
Large Transport	$39,171.36	$40,894.69	$56,192.10	$65,200	$10,980
Business Jet	$35,296.44	$36,849.30	$50,633.45	$13,300	$6,000
Regional Turboprop	$39,543.01	$41,282.69	$56,725.23	$26,980	$6,000
Regional Turbofan	$39,223.25	$40,948.87	$56,266.54	$25,840	$6,000

	MMEL Impact 10 day relief - Costs $			Cancelation Costs	Delay Costs
	Membrane System	PSA System	Cryo System	$ per day	$ per hr
Small Transport	$36,547.41	$38,155.30	$52,427.99	$26,600	$6,000
Medium Transport	$38,932.39	$40,645.21	$55,849.29	$35,000	$8,490
Large Transport	$34,147.00	$35,649.29	$48,984.56	$65,200	$10,980
Business Jet	$34,477.42	$35,994.24	$49,458.54	$13,300	$6,000
Regional Turboprop	$36,600.70	$38,210.94	$52,504.44	$26,980	$6,000
Regional Turbofan	$36,440.82	$38,044.03	$52,275.09	$25,840	$6,000

	MMEL Impact 120 day relief - Costs $			Cancelation Costs	Delay Costs
	Membrane System	PSA System	Cryo System	$ per day	$ per hr
Small Transport	$33,658.40	$35,139.19	$48,283.64	$26,600	$6,000
Medium Transport	$35,719.97	$37,291.46	$51,241.02	$35,000	$8,490
Large Transport	$30,797.43	$32,152.36	$44,179.53	$65,200	$10,980
Business Jet	$33,658.40	$35,139.19	$48,283.64	$13,300	$6,000
Regional Turboprop	$33,658.40	$35,139.19	$48,283.64	$26,980	$6,000
Regional Turbofan	$33,658.40	$35,139.19	$48,283.64	$25,840	$6,000

	Costs per year - Membrane system only (one event per day)				
	None	1 day	3 days	10 days	120 days
Small Transport	$137,663	$56,770	$39,436	$36,547	$33,658
Medium Transport	$164,217	$64,632	$41,824	$38,932	$35,720
Large Transport	$265,267	$81,041	$39,171	$34,147	$30,797
Business Jet	$66,419	$41,030	$35,296	$34,477	$33,658
Regional Turboprop	$139,581	$57,197	$39,543	$36,601	$33,658
Regional Turbofan	$133,826	$55,918	$39,223	$36,441	$33,658

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Small Transport											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.04	0.12	2.49
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.52	1.55	31.10
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.11	0.22	6.49
Compressor	16	7,000	100,000	1	11,096	2	0.5	0.5	0.37	1.12	22.42
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.12	0.36	7.29
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.08	0.25	5.09
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.12	0.36	7.29
Heat exchanger	14	100,000	100,000	1	11,621	2	1	1	0.36	1.43	21.41
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.07	0.18	4.25
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.09	0.26	5.21
Temperature sensor	0.15	50,000	50,000	2	26,247	2	2	4	0.16	1.26	9.48
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.08	0.23	4.63
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	1.04	3.11	62.20
Low flow air separation module	18	30,000	30,000	1	20,000	2	1	6	0.21	1.87	12.44
High flow shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.08	0.25	5.09
High flow air separation module	18	80,000	80,000	1	15,000	2	1	6	0.28	2.49	16.59
High flow check valve	1	100,000	100,000	1	41,995	1	1	1	0.10	0.30	5.92
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.08	0.39	4.67
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.15	0.46	9.24
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	1.04	34.21	62.20
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.41	1.66	24.88
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.05	0.52	3.11
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.05	0.83	3.11
System Totals	468.15			28	739	39	47.5	52	5.61	53.44	336.58

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Medium Transport											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.04	0.11	1.69
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.47	1.41	21.10
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.10	0.20	4.40
Compressor	102	7,000	100,000	1	12,000	3	0.5	0.5	0.31	1.25	14.06
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.11	0.33	4.95
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.08	0.23	3.45
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.11	0.33	4.95
Heat exchanger	36	100,000	100,000	1	11,621	4	1	1	0.32	1.94	14.52
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.06	0.16	2.88
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.08	0.24	3.54
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.14	0.57	6.43
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.07	0.21	3.14
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	0.94	2.81	42.19
Low flow air separation module	64	30,000	30,000	1	20,000	9	2		0.19	2.06	8.44
High flow shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.08	0.23	3.45
High flow air separation module	42.5	80,000	80,000	1	15,000	9	2	6	0.25	4.25	11.25
High flow check valve	1	100,000	100,000	1	41,995	1	1	1	0.09	0.27	4.02
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.07	0.35	3.17
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.14	0.42	6.27
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.94	30.94	42.19
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.38	1.50	16.88
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.05	0.47	2.11
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.05	0.75	2.11
System Totals	646.65			28	743	55	48.5	44	5.05	51.02	227.18

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Large Transport											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.05	0.14	1.44
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.60	1.80	18.04
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.13	0.25	3.77
Compressor	188	7,000	100,000	1	12,000	18	2	1	0.40	8.42	12.03
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.14	0.42	4.23
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.10	0.30	2.95
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.14	0.42	4.23
Heat exchanger	58	100,000	100,000	1	11,621	4	1	1	0.41	2.48	12.42
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.08	0.21	2.46
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.10	0.30	3.02
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.18	0.73	5.50
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.09	0.27	2.68
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	1.20	3.61	36.08
Low flow air separation module	110	30,000	30,000	1	20,000	18	2	6	0.24	6.25	7.22
High flow shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.10	0.30	2.95
High flow air separation module	67	80,000	80,000	1	15,000	18	2	6	0.32	8.34	9.62
High flow check valve	1	100,000	100,000	1	41,995	1	1	1	0.11	0.34	3.44
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.09	0.45	2.71
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.18	0.54	5.36
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	1.20	39.69	36.08
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.48	1.92	14.43
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.06	0.60	1.80
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.06	0.96	1.80
System Totals	825.15			28	743	88	50	50.5	6.48	78.76	194.27

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Business Jet											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.02	0.05	1.07
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.22	0.67	13.33
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.05	0.09	2.78
Compressor	16	7,000	100,000	1	11,096	2	0.5	0.5	0.16	0.48	9.61
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.05	0.16	3.13
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.04	0.11	2.18
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.05	0.16	3.13
Heat exchanger	14	100,000	100,000	1	11,621	2	1	1	0.15	0.61	9.18
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.03	0.08	1.82
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.04	0.11	2.23
Temperature sensor	0.15	50,000	50,000	2	26,247	2	2	4	0.07	0.54	4.06
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.03	0.10	1.98
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	0.44	1.33	26.66
Low flow air separation module	18	30,000	30,000	1	20,000	2	1	6	0.09	0.80	5.33
High flow shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.04	0.11	2.18
High flow air separation module	18	80,000	80,000	1	15,000	2	1	6	0.12	1.07	7.11
High flow check valve	1	100,000	100,000	1	41,995	1	1	1	0.04	0.13	2.54
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.03	0.17	2.00
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.07	0.20	3.96
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.44	14.66	26.66
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.18	0.71	10.67
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.02	0.22	1.33
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.02	0.36	1.33
System Totals	468.15			28	739	39	47.5	52	2.40	22.91	144.29

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Regional Turboprop											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.03	0.08	1.66
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.35	1.04	20.74
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.07	0.14	4.33
Compressor	16	7,000	100,000	1	11,096	2	0.5	0.5	0.25	0.75	14.95
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.08	0.24	4.86
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.06	0.17	3.40
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.08	0.24	4.86
Heat exchanger	14	100,000	100,000	1	11,621	2	1	1	0.24	0.95	14.28
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.05	0.12	2.83
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.06	0.17	3.48
Temperature sensor	0.15	50,000	50,000	2	26,247	2	2	4	0.11	0.84	6.32
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.05	0.15	3.08
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	0.69	2.07	41.47
Low flow air separation module	18	30,000	30,000	1	20,000	2	1	6	0.14	1.24	8.29
High flow shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.06	0.17	3.40
High flow air separation module	18	80,000	80,000	1	15,000	2	1	6	0.18	1.66	11.06
High flow check valve	1	100,000	100,000	1	41,995	1	1	1	0.07	0.20	3.95
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.05	0.26	3.11
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.10	0.31	6.16
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.69	22.81	41.47
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.28	1.11	16.59
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.03	0.35	2.07
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.03	0.55	2.07
System Totals	468.15			28	739	39	47.5	52	3.74	35.63	224.44

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Regional Turbofan											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.04	0.11	2.15
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.45	1.34	26.83
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.09	0.19	5.60
Compressor	16	7,000	100,000	1	11,096	2	0.5	0.5	0.32	0.97	19.34
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.10	0.31	6.29
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.07	0.22	4.39
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.10	0.31	6.29
Heat exchanger	14	100,000	100,000	1	11,621	2	1	1	0.31	1.23	18.47
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.06	0.15	3.66
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.07	0.22	4.50
Temperature sensor	0.15	50,000	50,000	2	26,247	2	2	4	0.14	1.09	8.18
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.07	0.20	3.99
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	0.89	2.68	53.66
Low flow air separation module	18	30,000	30,000	1	20,000	2	1	6	0.18	1.61	10.73
High flow shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.07	0.22	4.39
High flow air separation module	18	80,000	80,000	1	15,000	2	1	6	0.24	2.15	14.31
High flow check valve	1	100,000	100,000	1	41,995	1	1	1	0.09	0.26	5.11
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.07	0.34	4.03
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.13	0.40	7.97
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.89	29.51	53.66
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.36	1.43	21.46
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.04	0.45	2.68
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.04	0.72	2.68
System Totals	468.15			28	739	39	47.5	52	4.84	46.10	290.36

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Small Transport											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.04	0.12	2.49
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.52	1.55	31.10
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.11	0.22	6.49
Compressor	17	7,000	100,000	1	11,096	2	1	0.5	0.37	1.31	22.42
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.12	0.36	7.29
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.08	0.25	5.09
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.12	0.36	7.29
Heat exchanger	13	100,000	100,000	1	11,621	2	1	1	0.36	1.43	21.41
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.07	0.18	4.25
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.09	0.26	5.21
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.16	0.63	9.48
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.08	0.23	4.63
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	1.04	3.11	62.20
Air separation module	44	34,000	34,000	1	5,000	2	1	6	0.83	7.46	49.76
High flow valve	3	50,000	50,000	1	48,856	1	1	1	0.08	0.25	5.09
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.08	0.39	4.67
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.15	0.46	9.24
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	1.04	34.21	62.20
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.41	1.66	24.88
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.05	0.52	3.11
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.05	0.83	3.11
System Totals	475.45			26	708	35	45	43	5.86	55.81	351.39

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Medium Transport											
Cabin air filter assy	6	100000	100000	1	100000	1	1	1	0.03750375	0.11251125	1.68766875
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.47	1.41	21.10
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.10	0.20	4.40
Compressor	123	7,000	100,000	1	12,000	3	0.5	0.5	0.31	1.25	14.06
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.11	0.33	4.95
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.08	0.23	3.45
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.11	0.33	4.95
Heat exchanger	95	100,000	100,000	1	11,621	4	1	1	0.32	1.94	14.52
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.06	0.16	2.88
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.08	0.24	3.54
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.14	0.57	6.43
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.07	0.21	3.14
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	0.94	2.81	42.19
Air separation module	156.95	34,000	34,000	1	5,000	9	2		0.75	8.25	33.75
High flow valve	3	50,000	50,000	1	48,856	1	1	1	0.08	0.23	3.45
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.07	0.35	3.17
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.14	0.42	6.27
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.94	30.94	42.19
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.38	1.50	16.88
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.05	0.47	2.11
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.05	0.75	2.11
System Totals	776.1			26	711.4175143	45	45.5	37	5.271693379	52.69053751	237.2262021

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Large Transport											
Cabin air filter assy	6	100000	100000	1	100000	1	1	1	0.048107	0.144321	1.44321
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.60	1.80	18.04
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.13	0.25	3.77
Compressor	229	7,000	100,000	1	12,000	20	3	1	0.40	9.62	12.03
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.14	0.42	4.23
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.10	0.30	2.95
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.14	0.42	4.23
Heat exchanger	177	100,000	100,000	1	11,621	18	2	1	0.41	8.69	12.42
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.08	0.21	2.46
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.10	0.30	3.02
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.18	0.73	5.50
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.09	0.27	2.68
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	1.20	3.61	36.08
Air separation module	181	34,000	34,000	1	5,000	18	2	6	0.96	25.02	28.86
High flow valve	3	50,000	50,000	1	48,856	1	1	1	0.10	0.30	2.95
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.09	0.45	2.71
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.18	0.54	5.36
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	1.20	39.69	36.08
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.48	1.92	14.43
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.06	0.60	1.80
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.06	0.96	1.80
System Totals	988.15			26	711.4175143	85	49	43.5	6.76213321	96.24700457	202.8639963

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Business Jet											
Cabin air filter assy	6	100000	100000	1	100000	1	1	1	0.017775	0.053325	1.0665
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.22	0.67	13.33
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.05	0.09	2.78
Compressor	17	7,000	100,000	1	11,096	2	1	0.5	0.16	0.56	9.61
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.05	0.16	3.13
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.04	0.11	2.18
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.05	0.16	3.13
Heat exchanger	13	100,000	100,000	1	11,621	2	1	1	0.15	0.61	9.18
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.03	0.08	1.82
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.04	0.11	2.23
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.07	0.27	4.06
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.03	0.10	1.98
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	0.44	1.33	26.66
Air separation module	44.3	34,000	34,000	1	5,000	2	1	6	0.36	3.20	21.33
High flow valve	3	50,000	50,000	1	48,856	1	1	1	0.04	0.11	2.18
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.03	0.17	2.00
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.07	0.20	3.96
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.44	14.66	26.66
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.18	0.71	10.67
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.02	0.22	1.33
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.02	0.36	1.33
System Totals	475.45			26	707.9958632	35	45	43	2.510607889	23.92410081	150.6364734

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Regional Turboprop											
Cabin air filter assy	6	100000	100000	1	100000	1	1	1	0.02764875	0.08294625	1.658925
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.35	1.04	20.74
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.07	0.14	4.33
Compressor	17	7,000	100,000	1	11,096	2	1	0.5	0.25	0.87	14.95
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.08	0.24	4.86
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.06	0.17	3.40
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.08	0.24	4.86
Heat exchanger	13	100,000	100,000	1	11,621	2	1	1	0.24	0.95	14.28
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.05	0.12	2.83
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.06	0.17	3.48
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.11	0.42	6.32
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.05	0.15	3.08
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	0.69	2.07	41.47
Air separation module	44.3	34,000	34,000	1	5,000	2	1	6	0.55	4.98	33.18
High flow valve	3	50,000	50,000	1	48,856	1	1	1	0.06	0.17	3.40
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.05	0.26	3.11
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.10	0.31	6.16
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.69	22.81	41.47
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.28	1.11	16.59
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.03	0.35	2.07
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.03	0.55	2.07
System Totals	475.45			26	707.9958632	35	45	43	3.905213496	37.21358549	234.3128097

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Regional Turbofan											
Cabin air filter assy	6	100000	100000	1	100000	1	1	1	0.03577	0.10731	2.1462
Cabin air filter element		4,000	10,000,000	1	8,000	1	1	1	0.45	1.34	26.83
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.09	0.19	5.60
Compressor	17	7,000	100,000	1	11,096	2	1	0.5	0.32	1.13	19.34
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.10	0.31	6.29
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.07	0.22	4.39
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.10	0.31	6.29
Heat exchanger	13	100,000	100,000	1	11,621	2	1	1	0.31	1.23	18.47
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.06	0.15	3.66
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.07	0.22	4.50
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.14	0.55	8.18
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.07	0.20	3.99
Water separator/filter element		4,000	10,000,000	1	4,000	1	1	1	0.89	2.68	53.66
Air separation module	44.3	34,000	34,000	1	5,000	2	1	6	0.72	6.44	42.92
High flow valve	3	50,000	50,000	1	48,856	1	1	1	0.07	0.22	4.39
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.07	0.34	4.03
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.13	0.40	7.97
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.89	29.51	53.66
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.36	1.43	21.46
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.04	0.45	2.68
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.04	0.72	2.68
System Totals	475.45			26	707.9958632	35	45	43	5.052289407	48.14430863	303.1373644

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Small Transport											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.04	0.12	2.49
Cabin air filter element		4000	10,000,000	1	8,000	1	1	1	0.52	1.55	31.10
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.11	0.22	6.49
Compressor	3	7,000	100,000	1	11,096	1	0.5	0.5	0.37	0.75	22.42
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.12	0.36	7.29
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.08	0.25	5.09
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.12	0.36	7.29
Heat exchanger	0	100,000	100,000	1	11,621	1	1	1	0.36	1.07	21.41
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.07	0.18	4.25
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.09	0.26	5.21
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.16	0.63	9.48
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.08	0.23	4.63
Water separator/filter element		4000	10,000,000	1	4,000	1	1	1	1.04	3.11	62.20
Inlet shutoff valve	4	50,000	50,000	1	35,000	1	1	2	0.12	0.47	7.11
Crycooler bleed air valve	4	50,000	50,000	1	35,000	1	1	2	0.12	0.47	7.11
Flow sensor	0.1	20,000	20,000	1	20,000	1	10	2	0.21	2.70	12.44
Molecular sieve control valves	4	50,000	50,000	2	10,000	1	10	4	0.41	6.22	24.88
Molecular sieves	2.5	50,000	50,000	1	50,000	1	10	4	0.08	1.24	4.98
Purge heat exchanger	5	100,000	100,000	1	15,000	1	10	4	0.28	4.15	16.59
Purge heat exchanger valve-Air Side	4	50,000	50,000	1	35,000	1	10	4	0.12	1.78	7.11
Purge heat exchanger valve-Waste Side	4	50,000	50,000	1	35,000	1	10	4	0.12	1.78	7.11
LNEA Dewar Cooldown Valve	4	50,000	50,000	1	35,000	1	10	2	0.12	1.54	7.11
Inlet Recuperator	44	100,000	100,000	1	15,000	1	10	4	0.28	4.15	16.59
Inlet cooler	3	100,000	100,000	1	100,000	1	10	2	0.04	0.54	2.49
Cryocooler	117	8,000	8,000	1	8,000	6	2	4	0.52	6.22	31.10
LNEA Dewar	0	75,000	75,000	1	75,000	1	1	4	0.06	0.33	3.32
Dewar level sensor	0	50,000	50,000	1	50,000	1	1	2	0.08	0.33	4.98
Distillation column	6	50,000	50,000	1	50,000	1	1	4	0.08	0.50	4.98
Distillation column gas valve	4	50,000	50,000	1	35,000	1	1	2	0.12	0.47	7.11
Distillation column liquid valve	4	50,000	50,000	1	35,000	1	1	2	0.12	0.47	7.11
Temperature sensor	0.15	50,000	50,000	2	17,498	1	1	2	0.24	0.95	14.22
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.08	0.39	4.67
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.15	0.46	9.24
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	1.04	34.21	62.20
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.41	1.66	24.88
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.05	0.52	3.11
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.05	0.83	3.11
System Totals	611			44	515	53	142.5	90	8.05	81.48	482.84

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Medium Transport											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.04	0.11	1.69
Cabin air filter element		4000	10,000,000	1	8,000	1	1	1	0.47	1.41	21.10
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.10	0.20	4.40
Compressor	14.5	7,000	100,000	1	11,096	3	0.5	0.5	0.34	1.35	15.21
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.11	0.33	4.95
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.08	0.23	3.45
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.11	0.33	4.95
Heat exchanger	0	100,000	100,000	1	11,621	4	1	1	0.32	1.94	14.52
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.06	0.16	2.88
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.08	0.24	3.54
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.14	0.57	6.43
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.07	0.21	3.14
Water separator/filter element		4000	10,000,000	1	4,000	1	1	1	0.94	2.81	42.19
Inlet shutoff valve	4	50,000	50,000	1	35,000	1	1	2	0.11	0.43	4.82
Crycooler bleed air valve	4	50,000	50,000	1	35,000	1	1	2	0.11	0.43	4.82
Flow sensor	0.1	20,000	20,000	1	20,000	1	10	2	0.19	2.44	8.44
Molecular sieve control valves	4	50,000	50,000	2	10,000	1	10	4	0.38	5.63	16.88
Molecular sieves	2.5	50,000	50,000	1	50,000	1	10	4	0.08	1.13	3.38
Purge heat exchanger	5	100,000	100,000	1	15,000	1	10	4	0.25	3.75	11.25
Purge heat exchanger valve-Air Side	4	50,000	50,000	1	35,000	1	10	4	0.11	1.61	4.82
Purge heat exchanger valve-Waste Side	4	50,000	50,000	1	35,000	1	10	4	0.11	1.61	4.82
LNEA Dewar Cooldown Valve	4	50,000	50,000	1	35,000	1	10	2	0.11	1.39	4.82
Inlet Recuperator	82	80,000	80,000	1	15,000	1	10	4	0.25	3.75	11.25
Inlet cooler	3	100,000	100,000	1	100,000	1	10	2	0.04	0.49	1.69
Cryocooler	156	8,000	8,000	1	8,000	6	2	4	0.47	5.63	21.10
LNEA Dewar	0	75,000	75,000	1	75,000	1	1	4	0.05	0.30	2.25
Dewar level sensor	0	50,000	50,000	1	50,000	1	1	2	0.08	0.30	3.38
Distillation column	6	50,000	50,000	1	50,000	1	1	4	0.08	0.45	3.38
Distillation column gas valve	4	50,000	50,000	1	35,000	1	1	2	0.11	0.43	4.82
Distillation column liquid valve	4	50,000	50,000	1	35,000	1	1	2	0.11	0.43	4.82
Temperature sensor	0.15	50,000	50,000	2	17,498	1	1	2	0.21	0.86	9.64
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.07	0.35	3.17
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.14	0.42	6.27
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.94	30.94	42.19
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.38	1.50	16.88
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.05	0.47	2.11
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.05	0.75	2.11
System Totals	699			44	515	58	142.5	90	7.28	75.34	327.54

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Large Transport											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.05	0.14	1.44
Cabin air filter element		4000	10,000,000	1	8,000	1	1	1	0.60	1.80	18.04
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.13	0.25	3.77
Compressor	26	7,000	100,000	1	11,096	3	0.5	0.5	0.43	1.73	13.01
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.14	0.42	4.23
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.10	0.30	2.95
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.14	0.42	4.23
Heat exchanger	0	100,000	100,000	1	11,621	6	1	1	0.41	3.31	12.42
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.08	0.21	2.46
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.10	0.30	3.02
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.18	0.73	5.50
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.09	0.27	2.68
Water separator/filter element		4000	10,000,000	1	4,000	1	1	1	1.20	3.61	36.08
Inlet shutoff valve	4	50,000	50,000	1	35,000	1	1	2	0.14	0.55	4.12
Crycooler bleed air valve	4	50,000	50,000	1	35,000	1	1	2	0.14	0.55	4.12
Flow sensor	0.1	20,000	20,000	1	20,000	1	10	2	0.24	3.13	7.22
Molecular sieve control valves	4	50,000	50,000	2	10,000	1	10	4	0.48	7.22	14.43
Molecular sieves	2.5	50,000	50,000	1	50,000	1	10	4	0.10	1.44	2.89
Purge heat exchanger	5	100,000	100,000	1	15,000	1	10	4	0.32	4.81	9.62
Purge heat exchanger valve-Air Side	4	50,000	50,000	1	35,000	1	10	4	0.14	2.06	4.12
Purge heat exchanger valve-Waste Side	4	50,000	50,000	1	35,000	1	10	4	0.14	2.06	4.12
LNEA Dewar Cooldown Valve	4	50,000	50,000	1	35,000	1	10	2	0.14	1.79	4.12
Inlet Recuperator	120	60,000	60,000	1	15,000	1	10	4	0.32	4.81	9.62
Inlet cooler	3	100,000	100,000	1	100,000	1	10	2	0.05	0.63	1.44
Cryocooler	195	8,000	8,000	1	8,000	6	2	4	0.60	7.22	18.04
LNEA Dewar	0	75,000	75,000	1	75,000	1	1	4	0.06	0.38	1.92
Dewar level sensor	0	50,000	50,000	1	50,000	1	1	2	0.10	0.38	2.89
Distillation column	6	50,000	50,000	1	50,000	1	1	4	0.10	0.58	2.89
Distillation column gas valve	4	50,000	50,000	1	35,000	1	1	2	0.14	0.55	4.12
Distillation column liquid valve	4	50,000	50,000	1	35,000	1	1	2	0.14	0.55	4.12
Temperature sensor	0.15	50,000	50,000	2	17,498	1	1	2	0.27	1.10	8.25
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.09	0.45	2.71
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.18	0.54	5.36
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	1.20	39.69	36.08
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.48	1.92	14.43
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.06	0.60	1.80
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.06	0.96	1.80
System Totals	788			44	515	60	142.5	90	9.34	97.47	280.10

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Business Jet											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.02	0.05	1.07
Cabin air filter element		4000	10,000,000	1	8,000	1	1	1	0.22	0.67	13.33
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.05	0.09	2.78
Compressor	3	7,000	100,000	1	11,096	1	0.5	0.5	0.16	0.32	9.61
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.05	0.16	3.13
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.04	0.11	2.18
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.05	0.16	3.13
Heat exchanger	0	100,000	100,000	1	11,621	1	1	1	0.15	0.46	9.18
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.03	0.08	1.82
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.04	0.11	2.23
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.07	0.27	4.06
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.03	0.10	1.98
Water separator/filter element		4000	10,000,000	1	4,000	1	1	1	0.44	1.33	26.66
Inlet shutoff valve	4	50,000	50,000	1	35,000	1	1	2	0.05	0.20	3.05
Crycooler bleed air valve	4	50,000	50,000	1	35,000	1	1	2	0.05	0.20	3.05
Flow sensor	0.1	20,000	20,000	1	20,000	1	10	2	0.09	1.16	5.33
Molecular sieve control valves	4	50,000	50,000	2	10,000	1	10	4	0.18	2.67	10.67
Molecular sieves	2.5	50,000	50,000	1	50,000	1	10	4	0.04	0.53	2.13
Purge heat exchanger	5	100,000	100,000	1	15,000	1	10	4	0.12	1.78	7.11
Purge heat exchanger valve-Air Side	4	50,000	50,000	1	35,000	1	10	4	0.05	0.76	3.05
Purge heat exchanger valve-Waste Side	4	50,000	50,000	1	35,000	1	10	4	0.05	0.76	3.05
LNEA Dewar Cooldown Valve	4	50,000	50,000	1	35,000	1	10	2	0.05	0.66	3.05
Inlet Recuperator	44	100,000	100,000	1	15,000	1	10	4	0.12	1.78	7.11
Inlet cooler	3	100,000	100,000	1	100,000	1	10	2	0.02	0.23	1.07
Cryocooler	117	8,000	8,000	1	8,000	6	2	4	0.22	2.67	13.33
LNEA Dewar	0	75,000	75,000	1	75,000	1	1	4	0.02	0.14	1.42
Dewar level sensor	0	50,000	50,000	1	50,000	1	1	2	0.04	0.14	2.13
Distillation column	6	50,000	50,000	1	50,000	1	1	4	0.04	0.21	2.13
Distillation column gas valve	4	50,000	50,000	1	35,000	1	1	2	0.05	0.20	3.05
Distillation column liquid valve	4	50,000	50,000	1	35,000	1	1	2	0.05	0.20	3.05
Temperature sensor	0.15	50,000	50,000	2	17,498	1	1	2	0.10	0.41	6.10
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.03	0.17	2.00
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.07	0.20	3.96
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.44	14.66	26.66
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.18	0.71	10.67
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.02	0.22	1.33
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.02	0.36	1.33
System Totals	611			44	515	53	142.5	90	3.45	34.93	206.98

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Regional Turboprop											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.03	0.08	1.66
Cabin air filter element		4000	10,000,000	1	8,000	1	1	1	0.35	1.04	20.74
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.07	0.14	4.33
Compressor	3	7,000	100,000	1	11,096	1	0.5	0.5	0.25	0.50	14.95
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.08	0.24	4.86
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.06	0.17	3.40
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.08	0.24	4.86
Heat exchanger	0	100,000	100,000	1	11,621	1	1	1	0.24	0.71	14.28
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.05	0.12	2.83
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.06	0.17	3.48
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.11	0.42	6.32
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.05	0.15	3.08
Water separator/filter element		4000	10,000,000	1	4,000	1	1	1	0.69	2.07	41.47
Inlet shutoff valve	4	50,000	50,000	1	35,000	1	1	2	0.08	0.32	4.74
Crycooler bleed air valve	4	50,000	50,000	1	35,000	1	1	2	0.08	0.32	4.74
Flow sensor	0.1	20,000	20,000	1	20,000	1	10	2	0.14	1.80	8.29
Molecular sieve control valves	4	50,000	50,000	2	10,000	1	10	4	0.28	4.15	16.59
Molecular sieves	2.5	50,000	50,000	1	50,000	1	10	4	0.06	0.83	3.32
Purge heat exchanger	5	100,000	100,000	1	15,000	1	10	4	0.18	2.76	11.06
Purge heat exchanger valve-Air Side	4	50,000	50,000	1	35,000	1	10	4	0.08	1.18	4.74
Purge heat exchanger valve-Waste Side	4	50,000	50,000	1	35,000	1	10	4	0.08	1.18	4.74
LNEA Dewar Cooldown Valve	4	50,000	50,000	1	35,000	1	10	2	0.08	1.03	4.74
Inlet Recuperator	44	100,000	100,000	1	15,000	1	10	4	0.18	2.76	11.06
Inlet cooler	3	100,000	100,000	1	100,000	1	10	2	0.03	0.36	1.66
Cryocooler	117	8,000	8,000	1	8,000	6	2	4	0.35	4.15	20.74
LNEA Dewar	0	75,000	75,000	1	75,000	1	1	4	0.04	0.22	2.21
Dewar level sensor	0	50,000	50,000	1	50,000	1	1	2	0.06	0.22	3.32
Distillation column	6	50,000	50,000	1	50,000	1	1	4	0.06	0.33	3.32
Distillation column gas valve	4	50,000	50,000	1	35,000	1	1	2	0.08	0.32	4.74
Distillation column liquid valve	4	50,000	50,000	1	35,000	1	1	2	0.08	0.32	4.74
Temperature sensor	0.15	50,000	50,000	2	17,498	1	1	2	0.16	0.63	9.48
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.05	0.26	3.11
Oxygen sensor	1.5	26,933	26,933	1	26,933	1	1	1	0.10	0.31	6.16
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.69	22.81	41.47
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.28	1.11	16.59
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.03	0.35	2.07
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.03	0.55	2.07
System Totals	611			44	515	53	142.5	90	5.37	54.33	321.96

FULL-TIME OBIGGS PARTS LIST
CRYOGENIC DISTILLATION

Component	Unit weight (lbs)	Unit MTBMA	Unit MTBF	Quantity /Shipset	Component MTBUR Calc	Removal & Replacement Time Man Hours	Access Time Man Hours	Trouble-Shooting Time Man Hours	Annual Failure Rate	Labour Hours Per Year	Delays Per Year (Minutes)
Regional Turbofan											
Cabin air filter assy	6	100,000	100,000	1	100,000	1	1	1	0.04	0.11	2.15
Cabin air filter element		4000	10,000,000	1	8,000	1	1	1	0.45	1.34	26.83
OBIGGS shutoff valve	4	50,000	50,000	1	38,315	1	0.5	0.5	0.09	0.19	5.60
Compressor	3	7,000	100,000	1	11,096	1	0.5	0.5	0.32	0.64	19.34
Compressor discharge check valve	1	100,000	100,000	1	34,119	1	0.5	1.5	0.10	0.31	6.29
Bleed shutoff valve	3	50,000	50,000	1	48,856	1	1	1	0.07	0.22	4.39
Bleed check valve	1	100,000	100,000	1	34,119	1	1	1	0.10	0.31	6.29
Heat exchanger	0	100,000	100,000	1	11,621	1	1	1	0.31	0.92	18.47
Cooling fan	0	25,000	25,000	1	58,561	1	1	0.5	0.06	0.15	3.66
Bypass valve	3	50,000	50,000	1	47,737	1	1	1	0.07	0.22	4.50
Temperature sensor	0.15	50,000	50,000	2	26,247	1	1	2	0.14	0.55	8.18
Water separator/filter assy	10	100,000	100,000	1	53,789	1	1	1	0.07	0.20	3.99
Water separator/filter element		4000	10,000,000	1	4,000	1	1	1	0.89	2.68	53.66
Inlet shutoff valve	4	50,000	50,000	1	35,000	1	1	2	0.10	0.41	6.13
Crycooler bleed air valve	4	50,000	50,000	1	35,000	1	1	2	0.10	0.41	6.13
Flow sensor	0.1	20,000	20,000	1	20,000	1	10	2	0.18	2.33	10.73
Molecular sieve control valves	4	50,000	50,000	2	10,000	1	10	4	0.36	5.37	21.46
Molecular sieves	2.5	50,000	50,000	1	50,000	1	10	4	0.07	1.07	4.29
Purge heat exchanger	5	100,000	100,000	1	15,000	1	10	4	0.24	3.58	14.31
Purge heat exchanger valve-Air Side	4	50,000	50,000	1	35,000	1	10	4	0.10	1.53	6.13
Purge heat exchanger valve-Waste Side	4	50,000	50,000	1	35,000	1	10	4	0.10	1.53	6.13
LNEA Dewar Cooldown Valve	4	50,000	50,000	1	35,000	1	10	2	0.10	1.33	6.13
Inlet Recuperator	44	100,000	100,000	1	15,000	1	10	4	0.24	3.58	14.31
Inlet cooler	3	100,000	100,000	1	100,000	1	10	2	0.04	0.47	2.15
Cryocooler	117	8,000	8,000	1	8,000	6	2	4	0.45	5.37	26.83
LNEA Dewar	0	75,000	75,000	1	75,000	1	1	4	0.05	0.29	2.86
Dewar level sensor	0	50,000	50,000	1	50,000	1	1	2	0.07	0.29	4.29
Distillation column	6	50,000	50,000	1	50,000	1	1	4	0.07	0.43	4.29
Distillation column gas valve	4	50,000	50,000	1	35,000	1	1	2	0.10	0.41	6.13
Distillation column liquid valve	4	50,000	50,000	1	35,000	1	1	2	0.10	0.41	6.13
Temperature sensor	0.15	50,000	50,000	1	26,247	1	1	2	0.14	0.55	8.18
Relief valve	2.5	50,000	50,000	1	53,306	2	1	2	0.07	0.34	4.03
Oxygen sensor	1.5	26,933	26,933	2	17,498	1	1	1	0.20	0.61	12.27
Fuel tank check valve	0.5	100,000	100,000	5	4,000	1	24	8	0.89	29.51	53.66
Controller / control card	5.5	10,000	10,000	1	10,000	1	1	2	0.36	1.43	21.46
Ducting	345	10,000,000	10,000,000	1	80,000	6	2	2	0.04	0.45	2.68
Wiring	15	10,000,000	10,000,000	1	80,000	6	2	8	0.04	0.72	2.68
System Totals	611			44	515	53	142.5	90	6.95	70.23	416.74

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ADDENDUM F.D.1

CONFINED SPACE ENTRY LABOR & SAFETY EQUIPMENT ESTIMATE

to

APPENDIX F

AIRPLANE OPERATION AND MAINTENANCE FINAL REPORT

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Confined Space Entry Added Labor

System Concept	Aircraft	Inerting System Maint. Access per year	Other Maint. Access per Year	Additional M/H per entry	Annual M/H per Aircraft	Number of Aircraft	Annual Cost
Ground Based Inerting							
	Business Jet	0.1	6	0.75	4.6	8600	$2,950,875
	Turboprop	0.3	6	1.5	9.5	2000	$1,417,500
	Turbofan	0.2	6	1.5	9.3	1000	$697,500
	Small Transport	0.3	6	1.5	9.4	8600	$6,088,724
	Medium Transport	0.3	6	1.5	9.4	1400	$989,954
	Large Transport	0.4	6	1.5	9.6	2000	$1,443,853
						Total	**$13,588,406**
On-Board Ground Based Inerting							
Membrane	Business Jet	1.2	6	0.75	5.4	8600	$3,483,000
Membrane	Turboprop	1.8	6	1.5	11.7	2000	$1,755,000
Membrane	Turbofan	1.4	6	1.5	11.1	1000	$832,500
Membrane	Small Transport	2.2	6	1.5	12.4	8600	$7,970,757
Membrane	Medium Transport	1.9	6	1.5	11.9	1400	$1,247,379
Membrane	Large Transport	2.5	6	1.5	12.7	2000	$1,904,119
						Total	**$17,192,755**
On-Board Inert Gas Generating							
Membrane	Business Jet	3.2	6	0.75	6.9	8600	$4,455,238
Membrane	Turboprop	3.7	6	1.5	14.6	2000	$2,191,645
Membrane	Turbofan	4.8	6	1.5	16.3	1000	$1,219,430
Membrane	Small Transport	5.6	6	1.5	17.4	8600	$11,232,416
Membrane	Medium Transport	5.0	6	1.5	16.6	1400	$1,740,133
Membrane	Large Transport	6.5	6	1.5	18.7	2000	$2,807,054
						Total	**$23,645,917**
Cryogenic	Business Jet	4.6	6	0.75	8.0	8600	$5,129,934
Cryogenic	Turboprop	5.4	6	1.5	17.0	2000	$2,557,357
Cryogenic	Turbofan	6.9	6	1.5	19.4	1000	$1,456,387
Cryogenic	Small Transport	8.0	6	1.5	21.1	8600	$13,590,737
Cryogenic	Medium Transport	7.3	6	1.5	19.9	1400	$2,091,391
Cryogenic	Large Transport	9.3	6	1.5	23.0	2000	$3,450,721
						Total	**$28,276,527**

Confined Space Entry Safety Equipment Costs

	Gates	Maintenance Facilities	Gates per Kit	Kit Cost	Total Cost
121 Carriers	50,000		10	$ 3,977.92	$19,889,600
Air Freight Operations		5000	2	$ 3,977.92	$9,944,800
Corporate Aircraft		5000	2	$ 3,977.92	$9,944,800
Total					$39,779,200

Confined Space Entry Safety Equipment Quote

Quantity	Model	Description	Each	Total
1	1810-3606-0011	Industrial Scientific LTX312 Monitor with LEL & Oxygen Sensors	$ 1,096.68	$ 1,096.68
1	1810-2251	Charger	$ 56.01	$ 56.01
1	1810-1238	Calibration Gas unit, oxygen & pentane	$ 114.33	$ 114.33
1	1810-1766	Calibration Regulator	$ 137.20	$ 137.20
1	EF175XX	Ram Fan Model 75 Axial Blower, Explosion proof motor, ABS Carbon filled Housing. 2500cfm	$ 999.95	$ 999.95
2	1225C	12" Reinforced Conductive Duct, 25 feet	$ 651.25	$ 1,302.50
1	DC12	12" Duct to Duct coupler	$ 51.25	$ 51.25
2	BG12	Carrying case, duct	$ 75.00	$ 150.00
1	312	12" Duct Adapter	$ 70.00	$ 70.00
			Total	$ 3,977.92

Appendix G
Estimating & Forecasting

Appendix G

Estimating and Forecasting Task Team Final Report

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